# Engineering Record

A Weekly Journal Devoted to Civil Engineering and Contracting

PUBLISHED BY McGRAW PUBLISHING COMPANY, INC.

Volume 69 NEW YORK, SATURDAY, JANUARY 24, 1914 Number 4

## Colonel Gorgas Honored

IT has been a foregone conclusion that the services rendered at Panama by those who have the chief responsibility for the tremendous achievement would in due time receive what recognition lay in the power of the Government to give. To Colonel Gorgas has fallen the lot of receiving the first distinction. The President has nominated him as surgeon-in-chief of the army. While to the layman this may seem inadequate, it must be remembered that it is the highest post in Colonel Gorgas' profession in the gift of the Government. If the spirit of the appointment, and not the mere office is considered, Colonel Gorgas may well feel that the Nation has said to him "Well done!"

## New York Waterworks Section

THE most important action of the last convention of the American Waterworks Association was the amendment of the constitution authorizing the establishment of local and district sections. Now after the lapse of six months the New York section, embracing the States of New York and New Jersey, has been formed. Through the efforts of Mr. Allen Hazen about ninety active and associate members met at the Hotel Manhattan for the first meeting on Jan. 20. The first step in the association's extension has been taken. It should be followed by the early formation of other sections to the end that the good work of the association may reach and aid as many as possible in the waterworks field.

## Puzzlers for the Railroads

THE Interstate Commerce Commission has issued a circular dated December 20, 1913, and amended January 5, 1914, calling upon the railroads in the Central Freight Traffic Association territory, which have requested an advance of 5 per cent in freight rates, to answer a list of seventy-eight questions. Their character and the mass of unnecessary detail which they cover lead to the conclusion that the commission, which is a wise and able body, had little or nothing to do in framing them. They seem to be the product of visionary and impracticable theorists, devoid of practical knowledge of the management and operation of railways. If the railways were really seriously required to furnish this mass of data it would doubtless take years and millions of dollars to compile it, and thereafter years for the commission to digest and comprehend it. In all justice and fairness to the railways it may be stated that they have, under orders and regulations of the commission, furnished it with all data prescribed by the commission and if it is not in possession of the data to enable it to reach a just conclusion in the rate advance case, it is not the fault of the railways. Doubtless if the commission found it necessary to secure the data at its own expense and effort, many of the useless questions would be quickly eliminated.

## Dayton in the Public Eye

THE interest displayed by the newspapers of the country in the city-manager plan recently inaugurated in Dayton points to the opportunity given to engineers to prove to the public their fitness for important administrative positions. The plan is not new, but its adoption by so large a city as Dayton awakened the public prints when the same scheme applied in smaller cities had failed to arouse their interest. There has been much discussion in engineering journals, and some, too, in the newspapers, as to the fitness of engineers for important public offices. If they make a conspicuous success as city managers the newspaper notice that will result should be one of the most powerful agents in showing civil officials and the public the advantages to be derived from the appointment of engineers. Sumter, S. C., Staunton, Va., Dayton and the other places which have adopted the plan will be closely watched by the newspapers. While the latter are but passingly interested, the result to the engineer is of the greatest importance.

## Wireless in Railroad Service

THE successful use of wireless telegraphy in communicating with moving trains on the Delaware, Lackawanna & Western Railroad has been much exploited in the public prints, but the full significance of the wireless in railroad service has been overlooked. While communication with trains is the most spectacular feature of the work, the value of having a system of communication independent of interruptions by weather is very important. In a recent sleet storm, for example, in the Eastern section of the country, when wire service was interrupted, the Lackawanna was able to handle its messages satisfactorily through its fixed wireless stations. One other point that has not been sufficiently emphasized is the economy that will result in transmitting messages to heavy freight trains without the necessity of bringing them to a stop. The saving in time, wear and tear on equipment and in power is evident. The latest development in the Lackawanna's experiments is in setting signals by wireless. While it is unofficially reported that the experiments have had some success, full details as to the results have not yet been given out. It is apparent, therefore, that, far from being a toy or a curiosity, wireless holds forth great possibilities in railway service.

## Labor and Cost of Living

RECENT publications of the Department of Commerce and Labor throw considerable light on the causes of the increased cost of living, industrially speaking. Those economists and financiers who are seeking to account for high prices on the classical ground that the increased production of gold has lessened its purchasing power may be in the right, but they can never prove their case. More concrete evidence is available for explanation of at least a part of increased prices, and probably a large part. This evidence is in the form of the Government's figures giving the hours of labor and wages per hour in a number of important industries. Reducing these to percentages of decrease of hours and increase of wages, it is found that in the lumber industry, between 1890 and 1912, hours of labor per week decreased 3.8 per cent, while wages increased 29 per cent. Wood-mill workers have had their wages raised 33.4 per cent and their hours reduced 5 per cent. In the building trades as a whole hours have decreased 11.5 per cent and wages have gone up 63 per cent in twenty-two years. Marble and stone workers are enjoying an increase of wages of 28 per cent and work 7.6 per cent less than they did a few years ago. In the metal trades hours have been reduced 15.3 per cent and at the same time wages have been raised 36.8. If these increased wages represented increased skill and output it would not be so bad. But it is hard to find anyone who does not agree that workingmen of this day are less efficient than those of the previous generation, in spite of the better tools, equipment and working conditions with which they are now surrounded. It appears, then, that we must add relative inefficiency to shorter hours and higher wages in order to arrive at the full measure of the total addition that more expensive labor has made to the cost of construction and of living, too.

## Concrete Information Bureau

WHEN any form of construction springs into favor with great rapidity there is always danger that it will be misused by adventurous spirits. Too often this misuse is encouraged, not checked, by those profiting temporarily from the sales of machinery or materials. A conspicuous instance of the contrary policy has been shown by the Association of American Portland Cement Manufacturers. When it was formed twelve years ago the industry was well along in a period of rapid growth that is one of the conspicuous features of the history of American manufacturing. The low price to which cement had fallen and the development of the theory and practice of reinforced-concrete construction were working great changes in engineering and architecture. The association recognized the danger of this condition and at once took steps to collect and distribute information concerning the methods of using cement which were wise and those that were hazardous. With the help of specialists and, of late years, under the direction of an engineer acting as secretary and editor, the association has prepared books and pamphlets which cover practically every use of cement, and are distributed, without charge in most cases, from its office in the Land Title Building, Philadelphia. Many engineers and contractors are familiar with these publications, but it is not generally known that the association's office contains an excellent library relating to cement and concrete and a comprehensive collection of reports, photographs and notes covering most of the instructive concrete construction done up to recent date in the country. The association is glad to place this information at the disposal of those engaged in concrete work, so far as the limitations of its staff permit, for by so doing it can help to disseminate a knowledge of the rational use of cement. The work of the association is well illustrated by its activity in actually building concrete roads to ascertain the things to do and those to avoid, in critically investigating all such work in the country, to gather all the information the roads and their service records afford, and in publishing a pamphlet on the subject which is a thoroughly practical guide for both engineer and contractor. There has been poor concrete road construction, and doubtless there will be more in the future, but with the association's technical resources free for the asking, combined with the parallel work of the American Concrete Institute in drafting specifications, there is no excuse for mistakes in this or in any other use of cement.

## Those Rate Increases

THAT the railroads should get a fair deal is a matter of vital importance to the engineering profession and the construction industry; but, so far as the records show, nothing has been heard from either with reference to the increase of 5 per cent in freight rates for which the carriers are now seeking to obtain permission from the Interstate Commerce Commission. Several years ago, when a 10 per cent increase was sought, there was opposition from all quarters. Now the rare spectacle is afforded of shippers appearing before the commission to ask that the proposed increase be permitted, and in some cases the frank declaration has been made that shippers are willing to pay a trifling increase in rates in the belief that they will get their money back from better general business conditions.

If, as it appears, the public has come to a realization of the fact that poor railroads mean poor business for nearly everybody, the educational campaign that the railroads have been carrying on has produced at least one good result. At the present time, so far as additional expenditure is concerned, the roads are standing still, or going backward. Newspapers have been informing the public as to the number of men laid off on several roads; but there would be considerable surprise—not to say dismay —if it were known how far this movement has gone. The Pennsylvania Railroad Company, for example, has within the past few months decreased its roadway and shop force by 17,000 men. The simple explanation is that the road is cutting its coat according to its cloth.

With the railroads, which consume 50 per cent of the iron and steel produced and do a large share of the construction work performed throughout the country, practically "out of the market" until they find out how their earnings are going to run in the near future, and whether or not they are going to be allowed to earn enough money to keep their properties up to the mark, it behooves everyone who has an interest in, or convictions in regard to, the proposed rate increases to make himself heard. The Interstate Commerce Commission started upon its investigation of the asked-for increase with the idea that there would be great opposition to it and that great deliberation was the proper method to pursue. Very little opposition has been heard, and yet the commission's decision is delayed. This is regrettable from the standpoints of both the railroads and the business interests of the country. If the railroads are entitled to an increase of rates, they are entitled to it now. A delay of months will serve to make the situation still more serious for the roads.

## Failure of Stony River Dam

"INSUFFICIENCY of foundations" is the verdict in the case of the failure of the Stony River dam, which went out on Jan. 15. While for the greater part of the length of the structure the cutoff wall was carried to rock, it was stopped on hardpan, 10 ft. above the rock surface at the place where failure occurred. In this section there was visible after the structure went out a leaky seam 4 ft. wide and from 1/4 to 6 in. thick, only 8 in. below the bottom of the cutoff wall. This seam was filled with a mixture of sand, coal and some clay. When examined on Jan. 18, three days after the accident, water was running through it. Moreover, testimony indicates that on a line approximately normal to the axis of the dam and near this leaky seam were springs some distance both above and below the structure.

The explorations in the section where the cutoff wall was not carried to rock were limited to three test pits, from 18 to 22 ft. deep, from the bottom of which auger borings were taken to a depth of 14 ft., so that the total depth from the surface was 36 ft. The auger reached rock except in the pit farthest on the bank. Moreover, over the total length of the dam of 1065 ft. only twenty test pits were sunk, all of them on the center line of the dam.

It would appear, therefore, that the failure can be laid primarily to insufficient investigations of the dam site. Moreover, when rock was known to lie only 10 to 15 ft. below the level at which the cutoff wall was stopped at the point of failure there would seem to be no excuse for not carrying it to rock. It is evident that a point would come as the end of the dam was approached where this concrete cutoff wall would be very expensive and that stepping-up would be permissible. Where this point lies is a matter of judgment, but that it did not lie at buttress 15 is evident when it is known that the height of the structure at this point is about 31 ft.

A further criticism that may well be offered is that the gate mechanism was not housed, and, being frozen, prevented the drainage, or at least partial drainage, of the pond immediately after the first signs of failure were noticed. Had it been possible to operate the gates the structure might have been saved. The operating machinery should have been housed and the inclosing structure heated. It is stated that the watchman had been told to build a wooden housing for the valve year. This apparently does not exonerate the designers and, at best, would shift the responsibility to the watchman and those answerable for his conduct. Obviously the housing should have been built before the structure was turned over to the watchman.

The accident teaches a number of salutary lessons. Will they be learned or will others disregard them—to face in the future the same criticism that must now be leveled at those responsible for the Stony River collapse?

## Compensation of Engineers

ON page 105 is a reproduction of the curves of minimum, average and maximum yearly compensation for civil engineers included in a report of a special committee of the American Society of Civil Engineers. The attention which the curves will attract warrants their careful consideration. Before discussing them, however, it will be well to state that this journal, while believing that the average compensation of engineers is too low, does not feel that the case is hopeless, that merit will not be recognized or that constant whining is the proper attitude to assume. All three of these views, unfortunately, are widely held among certain classes in the profession.

The first impression one gathers from the curves is that the profession is indeed well paid. The averages run higher than expected. It is natural to question, then, whether these averages are correct. The committee, obviously, has endeavored earnestly to get accurate information and has submitted its results with the explanation that a more complete report is to follow. As the diagram stands, however, in spite of the fact that it is based on statements from half the membership of the society, there are a number of reasons for believing that it is not truly representative.

To begin with the organizations of two of the members of the committee may be considered. One of them is the State engineer of New York. His report on the Barge Canal for 1912 indicates that, excluding a few high-priced consultants hired by the day, the heads of sub-departments, of which there are about fifty, almost without exception come below the average. An average curve for the whole engineering organization would come still lower. Another member of the committee is the chief engineer of a railroad. If curves for his own staff will bear comparison with the committee's curves, his road is, indeed, a shining exception.

In this connection it is worth noting that in the New York Board of Water Supply, having one of the most competent engineering organizations ever assembled on this continent, the average salary for the engineering corps, exclusive of inspectors, transitmen, rodmen and axemen, is $2,460 per annum. As a check on the maximum curve it may be noted that the chief engineer of this organization receives a salary of $16,000 per annum.

Looking again at the question from the railroad angle it is apparent that railroad men constitute no small percentage of all civil engineers. Railroad men, however, are not as a rule members of the American Society of Civil Engineers. A comparison of the "Pocket List of Railroad Officials" with the 1913 year book of the society reveals the fact that of 458 men listed in strictly engineering positions on twenty representative railroads, only eighty-three, or about 18 per cent, are in the society. In this count roadmasters and supervisors, as well as superintendents and other operating officials, were excluded, although many of them are graduate engineers; inclusion of them would greatly reduce the percentage. The conclusion is obvious when the low salaries paid by the railroads are recalled.

In general, it is safe to say, those who apply for membership in the society are those who have been at least fairly successful. The requirements and financial considerations tend to keep the others out. Moreover, about half the society's membership responded to the request for information. It is reasonable to believe that this half was composed mostly of the elect; pride would silence the others, even though the information was to be sent so that the member could not be identified. The average shown in the curves, for these reasons, too, is thus likely to be considerably above the average for the whole profession.

It appears that while the fluctuations of the minimum curve have no discernible effect on the average, those of the maximum do have a decided effect. The two $150,000 men alone would give averages of $1,270 and $2,170 (comparing favorably with the minimum figures for their groups) if none of the others in those groups received anything. If each of the other sixty-eight men in the twenty-seventh year drew the minimum figure, $1,800, the average would be $3,940; if the $150,000 man were eliminated, the average for the other sixty-eight would be reduced to $5,935. Obviously, then, the influence of these maximum figures on the average is entirely disproportionate.

The curves, therefore, must be read with many reservations. They will be mistrusted, and possibly berated, by those who are discouraged or who constantly inveigh against the salaries paid the profession. To those who are looking upward, however, who are fitted for the work in which they are engaged, the curves are decidedly encouraging. They indicate that there is satisfactory emolument as well as a worthy career in engineering work. For the sake, however, of definitely finding the truth regarding the compensation of engineers, it is hoped that the committees can broaden its work, going even beyond the society, so that the factors above discussed may be eliminated and may not vitiate the results.

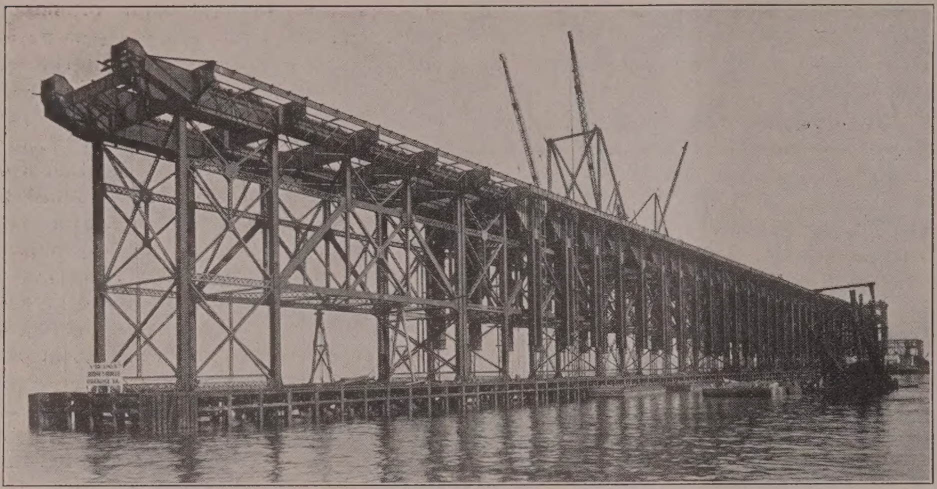
## Mixed vs. Penetration Roads

AMONG other recommendations made by the consulting engineers to the Commissioner of Efficiency and Economy of the State of New York with reference to the revision of road specifications is one that no more penetration roads should be built, all bituminous construction to be in the future by the mixing method. This recommendation has served to bring into prominence a discussion that has been going on for some time among engineers and others interested in road-building, a census of whom would probably show a very even division between the defenders and the opponents of penetration construction. The reason for this difference of opinion, so far as it can be ascertained, is that half of those who have stated opinions have had fortunate or favorable experience with penetration roads, while the other half have not.

On the merits of the case as they might be expressed on paper the impartial expert would be inclined to agree with the recommendations made to the Department of Efficiency and Economy. The ground for this agreement is mainly that the penetration method admits of so much uncertainty and irregularity that it is difficult to secure uniformly good work. The manner in which the bitumen is applied, the possibility that the stone will be dirty or cold, or both, and that the bitumen will be poured at too low a temperature or in insufficient quantity—all these are arguments against the penetration method. On the other hand, it is a fact that the best bituminous roads in the State of New York, for example, are the penetration roads constructed three or four years ago, under skilled supervision and with great care exercised at every stage of the work to secure the best results. So much cannot be said for New York's penetration roads built in the last year or two. In some cases they are not in as good condition as the older roads. But in New York, in many other parts of the country, and in England, it has been demonstrated beyond any question that splendid bituminous roads can be built by the penetration method; and wherever this is the rule—as it is in many places—it is useless to tell public authorities and engineers that penetration construction should be abandoned, for it will unquestionably be continued on the basis of results already obtained by this method. If the method is abandoned in New York it will mean the expenditure of more money without any assurance of better results unless a greater degree of care and skill is applied in the building of mixed roads than has been applied in penetration construction.

This brings us to a consideration of the merits of the mixed method. There are plenty of poor mixed roads to prove that this method is by no means infallible. But it is true, on the other hand, that by mixing hot stone and bitumen it is possible to obtain more dense surfaces, and the chances of securing a relatively perfect bond between stone and binder are greatly improved. But if there are laxness and absence of care and skill in building mixed roads, the result is as bad as or even worse than that obtained by the penetration method. Furthermore, the building of a mixed road requires a plant and equipment rarely available in road construction. It is difficult for most contractors to equip themselves with machines for heating a sufficient quantity of stone of large size to build mixed-method roads properly, and to this is due the greater number of failures of roads of this type. Incidentally, there is here an opportunity for someone to bring out a portable or semi-portable mixing plant with sufficient capacity to heat large stone in such quantities as will make the apparatus economical for use in road-building. There is said to be such a machine in use in England, but it has as yet found no market in this country.

If the foregoing is a fair summary of the case of mixed versus penetration roads, it appears that it would be foolish to abandon either method; but, rather, it should be demanded that in the application of both methods those provisions shall be insisted upon which experience has shown to be indispensable to success. There are good and bad penetration roads and both failures and successes of mixed-method roads; and, taking into consideration the difficulties and cost of mixed-method construction on a large scale, there is, to say the least, no more promise of general success by mixed construction than by the penetration method. It would, however, be extremely useful to have a more general discussion of this question and to draw out the experience of the country's road-builders and their opinions based on this experience as to the relative merits of the two forms of construction as the basis for determining whether or not the policy recommended for the State of New York should be generally adopted. There is, by the way, no particular reason for believing at the present time that the recommendations of the experts of the Department of Efficiency and Economy will be accepted without further consideration.



View of Pier Nearing Completion, with Erecting Travelers on Top

# Electrically Operated Steel Coal Pier of Norfolk & Western Railway

### Combined Use of Gravity and Machinery to Eliminate Locomotives, with Special Motor Pier Cars to Permit Quick Unloading

THE kind of facilities best adapted to the transshipment of coal from car to boat depends greatly on the volume of coal to be handled and the prevailing types of vessels receiving it. At Norfolk Harbor the coal brought from the West Virginia coal fields is delivered to vessels of all sizes—from small bay craft of 50 tons to colliers of 13,000 tons. These boats have hatches and coal-handling equipment of all sorts, and it is neither expedient to depend upon shoveling or excavating machinery to transfer the coal from mine car to boat nor to dump the cars bodily into the holds, as is done at certain points on the Great Lakes. The method adopted by the Norfolk & Western Railway at pier 4, its latest addition, just being completed at Lamberts Point, is somewhat different from any previously in use. The mine cars are dumped into special motor-driven pier cars, which are elevated to the top of the pier and emptied at will through bottom dumps into hoppers, from which chutes lead to the ships.

## SITE AND CAPACITY

Lamberts Point is the main water terminal of the Norfolk & Western. Local Norfolk cars are switched out at Portlock yard, 8 miles to the west. Before the building of pier 4 the facilities consisted of a flat receiving and classification yard, an engine terminal, a repair yard, three coal piers and two general merchandise piers. Of the coal piers—the longest of which was less than 900 ft. long—two were of timber and one of steel construction; they employed various combinations of gravity and power, representing different stages in the development of coal transshipment facilities. The yard was centrally located to the five piers, with the engine terminal and repair facilities on the north side.

Growth of business demanded a new coal pier, but space had first to be provided for it. The north side being the logical location, a new roundhouse and repair yard were built on the south side and the old facilities dismantled. The water surrounding the pier site was from 1 to 5 ft. deep. This was hydraulically dredged to a depth of 32 ft., the material being used to fill behind the established bulkhead lines. About 675,000 cu. yd. of material were thus transferred. The size of the dredge necessitated the use of numerous spillways to dispose of the water. Much of the lighter and less suitable matter passed over the spillways, but the heavier and better material was retained.

The new pier is 1200 ft. long, accommodating six ordinary ships or four of the longest colliers. Its capacity, a car per minute, is 50 per cent greater than that of pier 3 of the same terminal, which, according to figures recently presented before the American Society of Civil Engineers by Mr. J. E. Greiner, consulting engineer, of Baltimore, has a greater capacity than any other coal pier on the Atlantic seaboard. Electric cars, supplemented by gravity, do all the work, so that the steam locomotive is entirely eliminated.

## GENERAL OPERATION

The operations from the time the coal enters the main yard is as follows: The road trains come into the flat yard and are classified in a section of it. They are then pushed into a hump yard alongside the main yard, the hump being just beyond the switches at the entrance. From this point the engine is not needed except to clear the "empty" yard to the north. The hump yard consists of twelve tracks with a capacity of 400 cars, on a 1 per cent grade. The outlet of this yard is shown on the general plan, as are the successive movements. The road cars move by gravity over either track scale, continuing to a point where they are caught by one of the barneys, and pushed up an incline to the corresponding car dumper. Here they are overturned into the special pier cars, after which they move on to one of the kickbacks and return to the empty yard. The pier cars, electrically driven from an overhead trolley, move on the low level to the elevators which raise them to the top of the pier. They then move under their own power to the desired hopper, into which they are dumped almost instantaneously, the bottoms dropping down. They then advance to the end of the pier and return on a 6.25 per cent incline down the center of the pier to the starting point at the car dumpers.

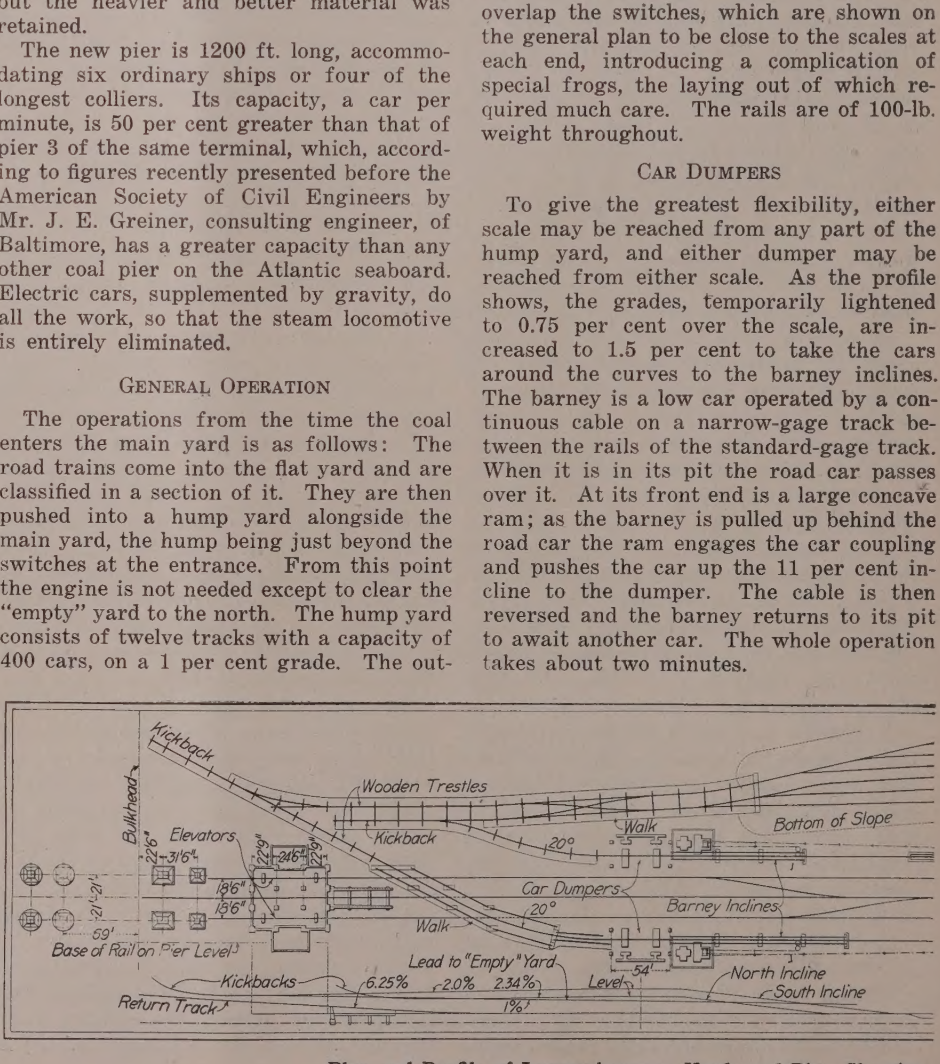
## SCALES

The track scales are of the Fairbanks-Morse type, 68 ft. long and of 200-ton capacity. No overhang is used, the railroad company believing it has found a better solution of the problem of eliminating shock when the car comes on the end of the scale by the use of flexible rails. A short rail reinforced on the under side with another rail bottom up spans a gap of about 8 ft. from the end of the scale pit to a suitable point over the first lever, and is pivot-jointed to the adjacent rails at each end. Thus each axle load is applied gradually on the scale.

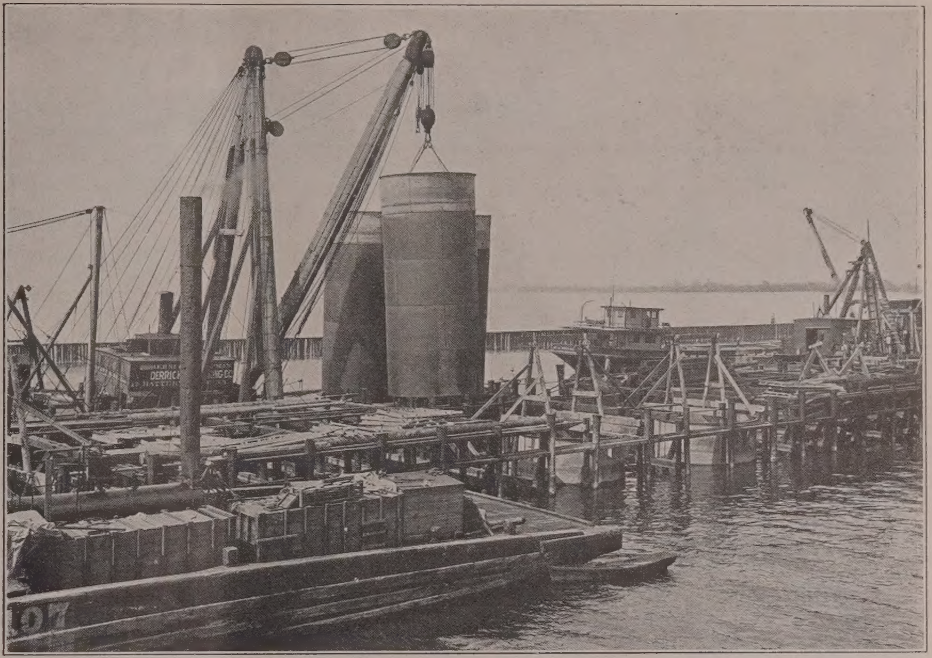
Each scale has a dead track for the passage of locomotives. These dead tracks overlap the switches, which are shown on the general plan to be close to the scales at each end, introducing a complication of special frogs, the laying out of which required much care. The rails are of 100-lb. weight throughout.

## CAR DUMPERS

To give the greatest flexibility, either scale may be reached from any part of the hump yard, and either dumper may be reached from either scale. As the profile shows, the grades, temporarily lightened to 0.75 per cent over the scale, are increased to 1.5 per cent to take the cars around the curves to the barney inclines. The barney is a low car operated by a continuous cable on a narrow-gage track between the rails of the standard-gage track. When it is in its pit the road car passes over it. At its front end is a large concave ram; as the barney is pulled up behind the road car the ram engages the car coupling and pushes the car up the 11 per cent incline to the dumper. The cable is then reversed and the barney returns to its pit to await another car. The whole operation takes about two minutes.



Plan and Profile of Layout between Yards and Pier, Showing



Placing Cylindrical Steel Caissons for Substructure of Pier

The car dumpers are designed to handle any sort of roofless cars used in road service to convey coal. One of the illustrations shows the dumper in the foreground. As the car comes on the dumper it clears the inner vertical side of the machine by a few inches. Four heavy steel clamps drop on the car. They are flat where they bear on the sides of the car and sharp in the middle, to crush away more readily the heaped-up coal. At the same time the track moves laterally until the side of the car is brought solid against the vertical face of the machine, which becomes the support as the car is overturned in that direction. The relation of dumper and pier track is such that all the coal goes into the pier car, aided by an apron set at a proper angle opposite the dumper.

After the car is dumped it is pushed off the machine by the next car. The track on the north dumper is just high enough to allow the coal to be dumped into the high-sided pier car, the difference in the elevation of the two tracks being about 15 ft. The south dumper is about 7 ft. higher, to give clearance above the pier tracks as the empty cars cross overhead on their way to the "empty" yard. The empty cars move by gravity to their respective kickbacks, thence back—also by gravity—to the empty yard.

### PIER CARS

Each of the twelve pier cars has a capacity of 100 tons, so that each car will take the contents of two of any but the largest road cars. Carrying their loads on the low level from the dumpers, they are lifted by one of the two elevators to the top of the pier, which is 90 ft. above water level.

One of the drawings shows the general arrangement of the pier. It will be seen that the structure is of the viaduct type, with alternate spans of 30 and 90 ft., and truss panel lengths of 30 ft. This unit of 30 ft. is such that the hopper, which occupies the entire panel, will just take the contents of a full car, which has a bottom opening 26 ft. long. This uniformity of panel length, together with the level grade of the track—made possible by the use of electric power to move the cars—makes all of the thirty-one hoppers on each side of the pier interchangeable—a feature not attained when gravity is depended upon to move the cars.

Experience has shown that with the rectangular pyramidal hopper the coal will bank up in the angles where the slope is less than the normal for coal. This objection has been obviated by using a many-sided pyramid, giving an approximation of a truncated cone with uniform slopes. Each bunker will hold 4800 cu. ft., which is 20 per cent in excess of the level capacity of the pier car. From each hopper project a fixed vertical chute and a movable chute extending outward, so designed as to allow both vertical and pivotal movement, so that the delivery point may be anything from 5 to 47 ft. above high water at a point 25 ft. from the pier fender.

After the pier car has been unloaded by dropping the car bottom it moves forward to the end of the pier and then returns down the 6.25 per cent incline in the center of the pier, whence it is switched back to either car dumper to receive a new load.

### SWITCHES

In the cycle of operations not only is the locomotive eliminated, but also the number of men necessary is believed to be reduced to a minimum. Effort was made to make the whole layout as compact as possible and to bring everything as near as could be to the bulkhead line. The general plan shows how fully the available space has been utilized. Spring switches have been used not only at the kickbacks but also at the trailing switches in the vicinity of the track scale. At the latter switches a separate stand controls each switch point to allow the emergency passage of locomotives. The facing switches are ordinarily set to allow each part of the plant to be worked independently, although the multiplicity of crossovers prevents an accident on one side from putting all the facilities on that side out of commission. Car riders are required to bring the loaded road cars down across the scales to the barneys, and other riders take them in charge at the entrance to the "empty" yard. One switchman can readily attend to the switches at the track scales, and another can control the distribution in the "empty" yard.

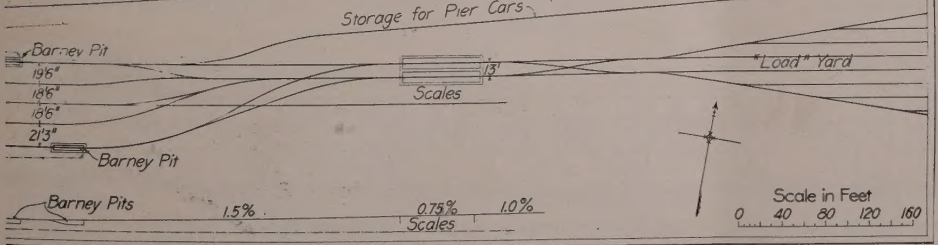
Power is received from an electric railway near by and transformed in a house near the scales. This plant has duplicate facilities, with a permanent traveling crane over the machines to permit their easy removal and replacement. Twin houses at the dumpers contain the dumper and barney machinery, and other buildings at the elevators house the machinery therefor. The power is supplied to the pier cars by overhead wires.

### CONSTRUCTION

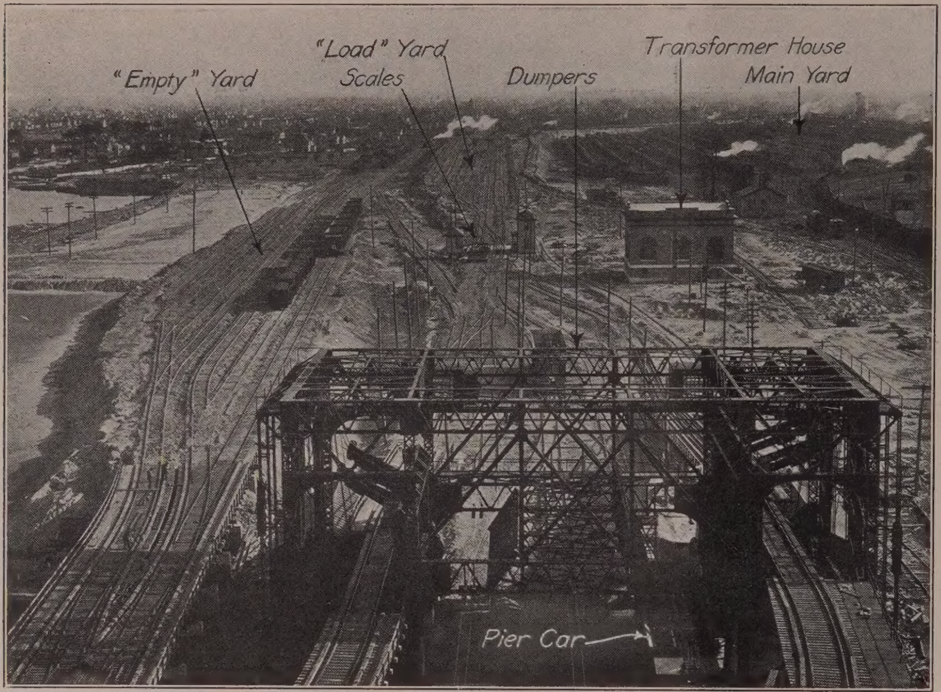
The fact that the layout is on made ground and the uncertainty as to what dredging operations might be carried on in later years made the design of a suitable bulkhead something of a problem. Details are shown of the design adopted. The bulkhead proper was anchored to a row of plumb and batter piles set 45 ft. back. Along the north side, parallel to the layout, a simpler system was used.

Construction of the elevator foundation was carried on under difficulty, at a time when the hydraulic filling was going on and the pit was practically surrounded by water. A solid concrete floor, reinforced with a large number of old rails, was built on a foundation of about 500 piles. The piles were from 50 to 80 ft. in length.

With the use of extension leads a cluster of about sixty-five piles was driven for each pier pedestal until the tops were 27 ft. below low water. Details are shown of the pedestals. Dredging had previously been carried down to a depth of 32 ft. below low water. Steel cylindrical shells 18 ft. in diameter and 41 ft. high were set over each cluster and forced down until the bottoms were 8 ft. below the tops of piles, the tops then being 3 ft. above high water. Suction equipment was utilized to remove as much of the muck as possible from around the heads of the piles. Bags of cement were deposited by a diver around the inner rim of the shell, and clean gravel was put in to absorb such of the muck



Scales, Barney Inclines, Car Dumpers, Kickbacks and Elevators

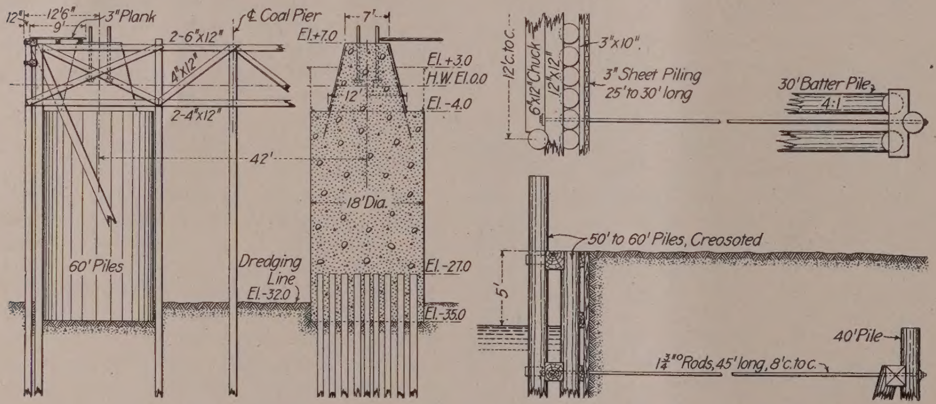


Looking Down on Dumpers from Top Position of Elevator

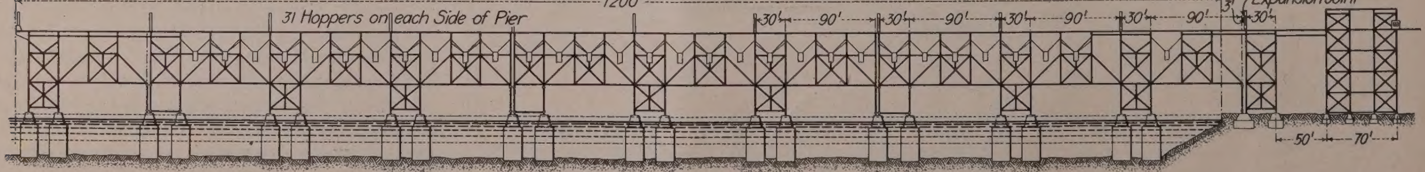
as could not be removed by suction. Concrete was then placed from bottom-dump buckets to sufficient thickness to withstand the upward pressure, still leaving the tops of piles exposed when the water was removed. The cylinders were then unwatered, and the remainder of the concrete was placed in the dry. As the detail drawing shows, the concrete cylinders were brought up to an elevation of — 4, and on top of these were placed the concrete pyramids carrying the steel columns. The upper 7 ft. of the steel cylinders were removed after the concrete had all been placed.

The main members of the steelwork were placed by travelers carrying two steel derricks with 90-ft. booms. A smaller traveler with a single boom followed and placed the hoppers, chutes and trolley poles.

The hydraulic dredging and foundations for the pier and elevator were handled by Henry Steers, Inc., of New York. J. P. Pettijohn & Company, of Lynchburg, Va., built the remaining concrete work and foundations, the transformer house, engine house and shop buildings. The Virginia Bridge & Iron Company, of Roanoke, Va., furnished and erected all steel with the exception of the dumpers and elevators, which were furnished by the Wellman-Seaver-Morgan Company, of Cleveland. All electric machinery is of the Westinghouse make. The timber trestles at the kickbacks were built by company forces, who also handled the track work and the dry fill for the hump yard, which amounted to about 250,000 cu. yd. The work was started under the general direction of Mr. Charles S. Churchill, at that time chief engineer, from designs prepared by Mr. J. E. Crawford, then bridge engineer, and Mr. C. C. Wentworth, principal assistant engineer. As acting chief engineer Mr. Crawford directed the latter part of the work. Mr. W. P. Wiltsee, assistant engineer on construction, had direct charge.



Details of Submerged Pedestals and of Reinforced Timber Bulkhead



Longitudinal Elevation of Pier, Showing Location of Hoppers and of 3-Foot Expansion Joints

## Record Production of Portland Cement in 1913

### U. S. Geological Survey Estimate Shows Nearly 10,000,000 Barrel Increase

According to returns received by the U. S. Geological Survey up to Jan. 12, 1914, it is estimated by Mr. Ernest F. Burchard that the quantity of Portland cement manufactured in the United States in 1913 was approximately 92,406,000 bbl., compared with 82,438,096 bbl. in 1912, an increase of about 9,967,900 bbl., or 12 per cent. The estimated shipments of Portland cement during 1913 were 88,853,000 bbl., compared with 85,012,556 bbl. in 1912, an increase of about 3,840,400 bbl., or 4.5 per cent.

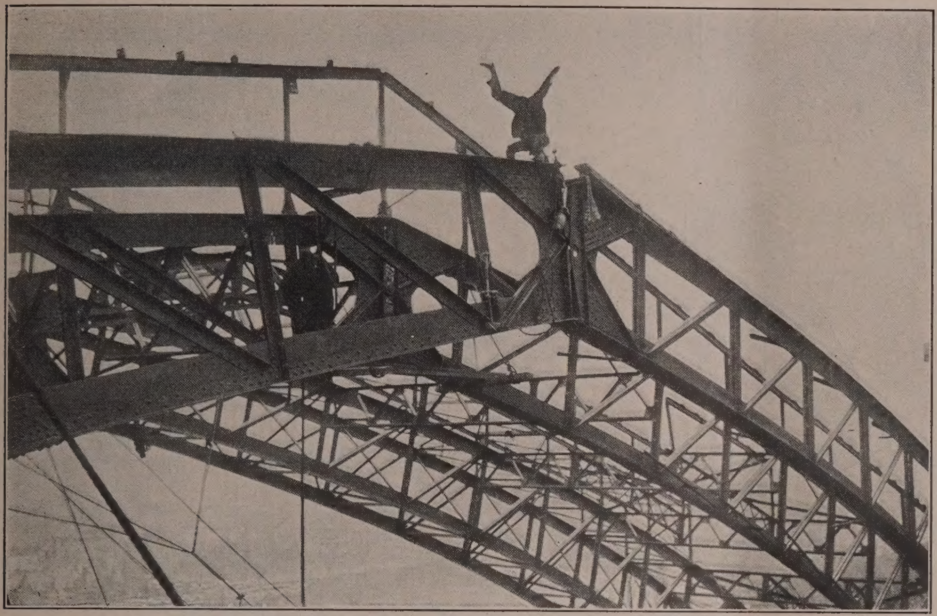
The average value per barrel was appreciably higher than in 1912. Increases of 10 to 25 cents a barrel are reported from several plants in the Central and Eastern States, but there were slight decreases reported from a few plants in the Rocky Mountain district. Two new plants, both in Washington, were added to the list of producers during 1913.

The following table gives, by commercial districts, the estimated production, shipments and stocks for 1913 and the actual production, shipments, and stocks for 1912, together with the per cent of change:

Portland Cement Production in the United States in 1912 and Estimate for 1913, by Districts (in Barrels)

| | 1912 | Estimate, 1913 | Change, per cent. Increase |
|---|---|---|---|
| *Lehigh District (Eastern Pennsylvania and Western New Jersey)* | | | |
| Production | 24,762,083 | 27,079,000 | 9.4 |
| Shipment | 26,013,891 | 26,734,000 | 2.8 |
| Stock | 1,927,495 | 2,332,000 | 21.0 |
| *New York State* | | | |
| Production | 4,492,806 | 5,208,000 | 15.9 |
| Shipment | 4,543,060 | 5,239,000 | 15.3 |
| Stock | 555,989 | 430,000 | *22.7 |
| *Ohio and Western Pennsylavina* | | | |
| Production | 7,359,402 | 7,704,000 | 4.7 |
| Shipment | 7,398,753 | 7,302,000 | *1.3 |
| Stock | 640,672 | 1,027,000 | 60.3 |
| *Michigan and Northeast Indiana* | | | |
| Production | 4,308,645 | 5,065,000 | 17.6 |
| Shipment | 4,417,808 | 4,967,000 | 12.4 |
| Stock | 515,619 | 609,000 | 18.0 |
| *Southern Indiana and Kentucky* | | | |
| Production | 3,091,603 | 3,006,000 | *2.8 |
| Shipment | 3,134,841 | 2,861,000 | *8.7 |
| Stock | 285,422 | 437,000 | 53.1 |
| *Illinois and Northwest Indiana* | | | |
| Production | 10,659,357 | 12,406,000 | 16.4 |
| Shipment | 10,677,479 | 11,566,000 | 8.3 |
| Stock | 1,106,547 | 1,942,000 | 75.5 |
| *Southeastern States (Alabama, Georgia, Maryland, Tennessee, Virginia, West Virginia)* | | | |
| Production | 4,737,257 | 5,724,000 | 20.8 |
| Shipment | 5,081,209 | 5,492,000 | 8.1 |
| Stock | 348,182 | 623,000 | 78.9 |
| *Iowa and Missouri* | | | |
| Production | 7,583,933 | 8,427,000 | 11.1 |
| Shipment | 7,804,901 | 7,962,000 | 2.0 |
| Stock | 893,720 | 1,363,000 | 52.5 |
| *Great Plains States (Kansas, Oklahoma and Central Texas)* | | | |
| Production | 5,807,043 | 6,200,000 | 6.8 |
| Shipment | 6,174,085 | 6,090,000 | *1.4 |
| Stock | 708,657 | 789,000 | 11.3 |
| *Rocky Mountain States (Colorado, Utah, Montana, Arizona and Western Texas)* | | | |
| Production | 2,299,252 | 2,671,000 | 16.2 |
| Shipment | 2,234,602 | 2,568,000 | 14.9 |
| Stock | 222,037 | 312,000 | 40.5 |
| *Pacific Coast States (California and Washington)* | | | |
| Production | 7,336,715 | 8,916,000 | 21.5 |
| Shipment | 7,531,927 | 8,072,000 | 7.2 |
| Stock | 606,989 | 1,511,000 | 148.9 |
| *Total* | | | |
| Production | 82,438,096 | 92,406,000 | 12.1 |
| Shipment | 85,012,566 | 88,853,000 | 4.5 |
| Stock | 7,811,329 | 11,375,000 | 45.6 |

*Decrease.



Center Panels of Arches after Erection of First Pair of Trusses

# Immense Armory for Eighth Artillery District, New York

### Drill-Hall Roof with Twenty-Eight Three-Hinge Arch Trusses of 289-Foot Span over Clear Floor Space 295 x 594 Feet

THREE-HINGED arch trusses with spans of 288 ft. 10 in. to roof a drill hall with an unobstructed floor space 295 ft. wide and 594 ft. long, claimed to be the largest permanent hall ever built, are the principal features of the new armory building for the Eighth Artillery District which is now under construction at Kingsbridge Road and Jerome Avenue, New York City. Several buildings with much larger unobstructed floor space and higher roof trusses have been erected—among them the 300 x 589-ft. trainshed of the Pennsylvania Railroad in Philadelphia, the 362 x 1687-ft. Liberal Arts Building at the Chicago Exposition of 1893, and the 363 x 1378-ft. Machinery Hall at the Paris Exposition of 1889, all of which were described in the Engineering Record. The two latter, however, were only temporary structures, and the drill hall of the Eighth Artillery District armory is claimed to be the largest permanent hall in the world.

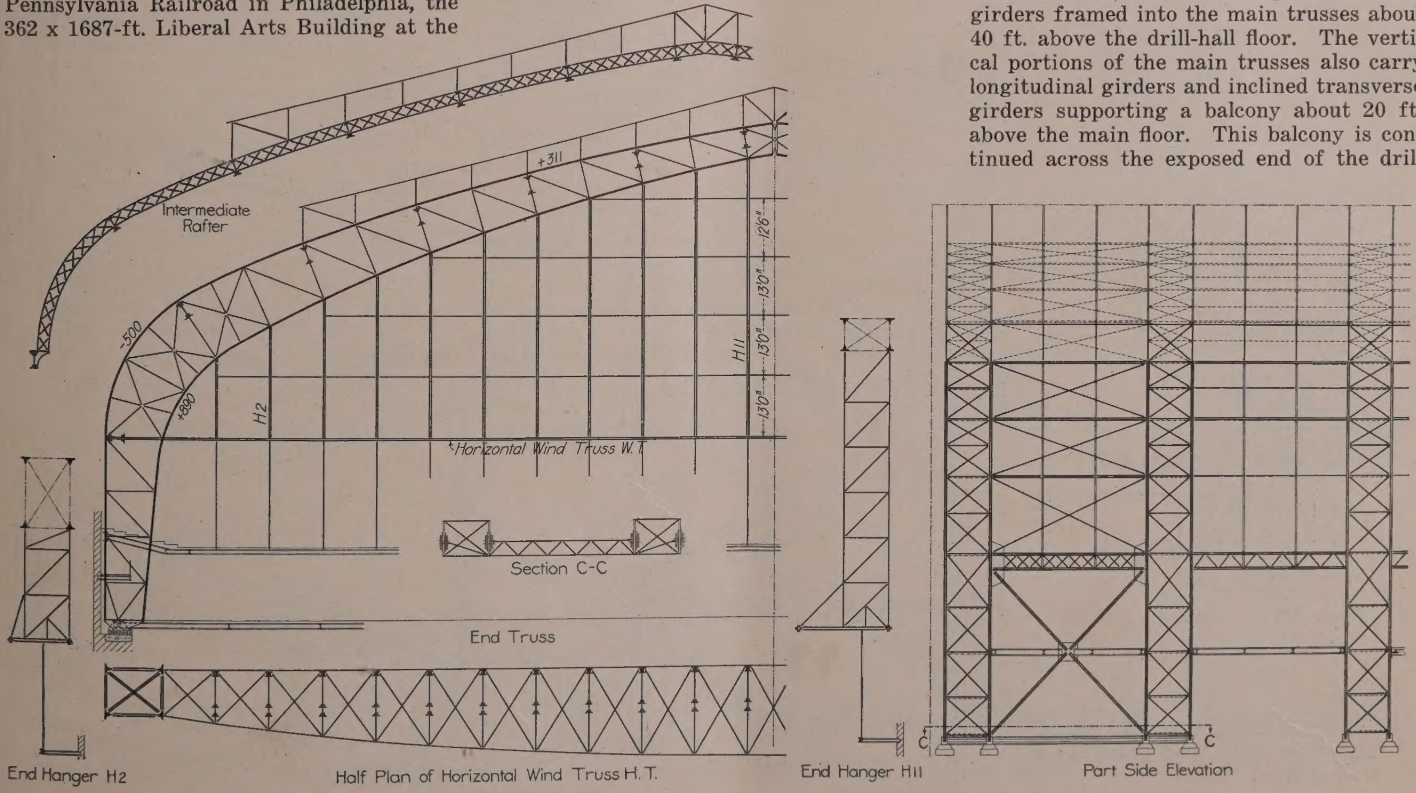
The drill hall is inclosed by brick walls about 40 ft. high on the east and west ends and on the north side; against the south side is placed the administration building. The roof is carried independently of the walls on fourteen pairs of three-hinge arch trusses with a span of 288 ft. 10 in. and a rise of about 108 ft. on centers of pins. The roof is surmounted by a concentric 170 x 400-ft. monitor, 8 ft. high. The trusses weigh about 100,000 lb. each and are being erected in complete halves by derricks on two large wooden tower travelers running on the previously erected drill-hall floor. The general construction and principal details of the roof design are here described.

### DESIGN OF FRAMEWORK

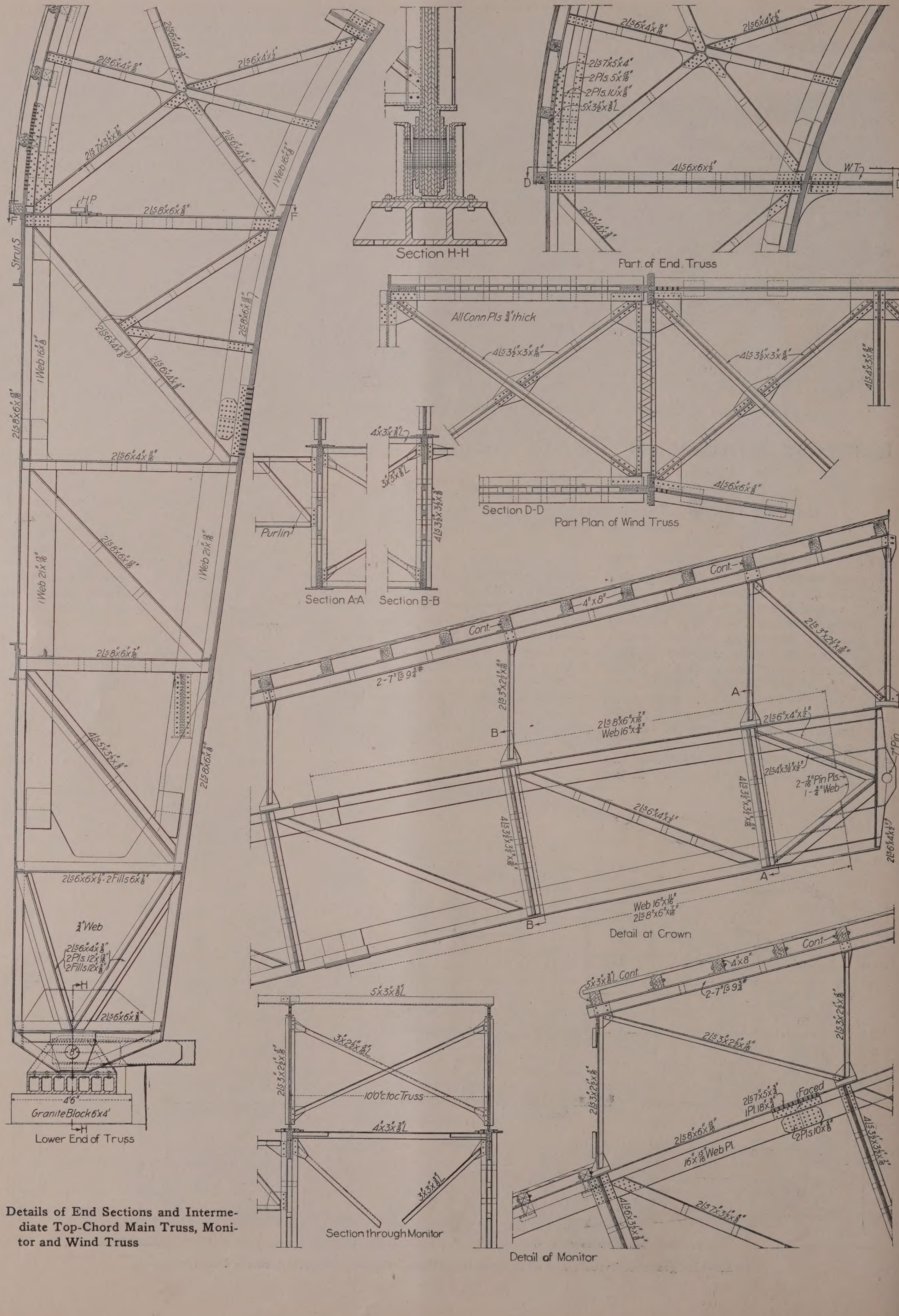
The structural steel framework, weighing in all about 7,500,000 lb. exclusive of the drill-hall floor, lower floor and administration building, is supported entirely by the roof trusses. Except for one special panel of 32½ ft. at each end, they are spaced alternately 10 ft. and 35 ft. apart. The trusses in the 10-ft. panels are connected by angle-iron X-bracing in the planes of the top and bottom chords and by transverse X-bracing in planes radial to the curve of the chords, thus making fourteen independently stable double ribs, separated by eleven 35-ft. panels and two 32½-ft. panels.

The roof is symmetrical about the longitudinal and transverse center lines, and all of the intermediate ribs and panels are duplicates. The 32½-ft. end panels are X-braced with single 3 x 4 and 5 x 5-in. angles in the planes of the top chords. The roof at both the exposed ends is braced by a horizontal wind truss about 40 ft. above the drill-room floor. Otherwise the structural framework is not braced except by the longitudinal members and by the wooden roof sheathing.

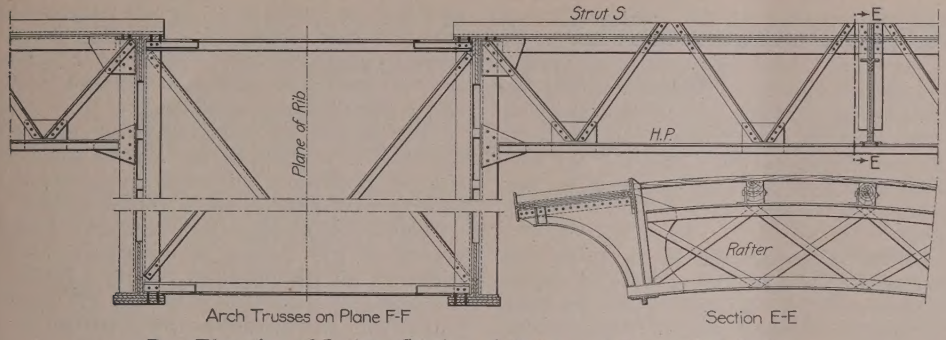
Longitudinal wooden purlins are carried on the monitor frames, on the top chords of the arch trusses, and on the top flanges of two intermediate rafters in each long panel. The rafters are of light lattice-girder construction and are supported by lattice-girder main purlins connecting the main trusses, and on longitudinal wall girders framed into the main trusses about 40 ft. above the drill-hall floor. The vertical portions of the main trusses also carry longitudinal girders and inclined transverse girders supporting a balcony about 20 ft. above the main floor. This balcony is continued across the exposed end of the drill



General Diagrams of Trusses and Bracing for Roof Construction of Eighth Artillery District Armory



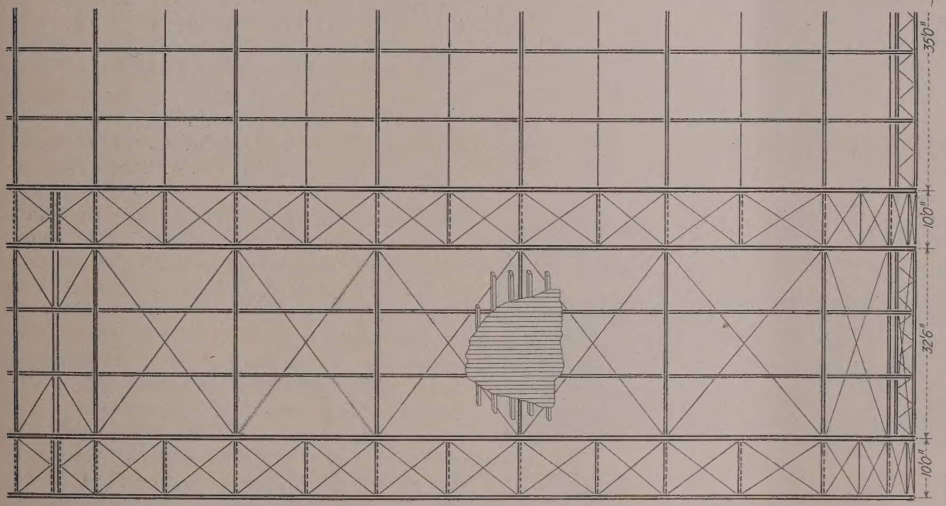
**Details of End Sections and Intermediate Top-Chord Main Truss, Monitor and Wind Truss**



**Part Elevation of Lowest Section of Rafter and Supporting Girder**

hall, where the outer edge is suspended from the horizontal wind truss in the end rib of the framework.

Simple construction characterizes the monitor framework, which consists of inclined rafters made of pairs of 7-in. channels in the planes of the main trusses and rafters and supported from them on pairs of 2 x 3½-in. vertical rafters braced by diagonal angles in the center and end panels of each truss. The end panels of rafters and two intermediate panels near the center are also X-braced by single 3 x 3-in. angles.



Part Plan of Roof Trusses, Eaves to Center Line

Except for the pins at the crown and skewback hinges of the main trusses, all connections are riveted. No provision is made for longitudinal temperature movement, and transverse expansion and contraction are provided for by the rise and fall of the arch trusses on their hinge pins. The total dead load of the roof, including an assumed weight of 20 lb. of snow, amounts, on the flat top, to 50 lb. per square foot, which it is proportioned to carry besides an assumed horizontal wind pressure of 30 lb. per square foot reduced to normal by Duchemin's formula. The design, materials, and shop work conform to the requirements for high-class bridge construction, and the work was fabricated with such accuracy that the assembling in the field has proved to be satisfactory. In the fabricating shop all truss work was laid out to wooden templates and all chords assembled with dummy struts between chords and reamed and match-marked. The diagonal numbers were not assembled in the trusses on account of the difficulty of forcing them into position.

The main-arch trusses have T-shaped top and bottom chords, with the inclined upper portions connected to the vertical lower portions by curved sections at the haunches. They are divided by radial members into panels of different lengths braced between the haunches and the crown and below the haunches by single diagonals, and at the haunches by intersecting diagonals, with intermediate radials at their intersection. The trusses are carried on fixed pedestals, with skewback pins connected under the floor by horizontal members consisting of spliced floorbeams proportioned for a tensile stress of 200,000 lb., as well as for the shears and bending moments due to floor loads. The maximum stresses in 1000-lb. units for the different truss members are shown on the diagram, marked plus for compression and minus for tension.

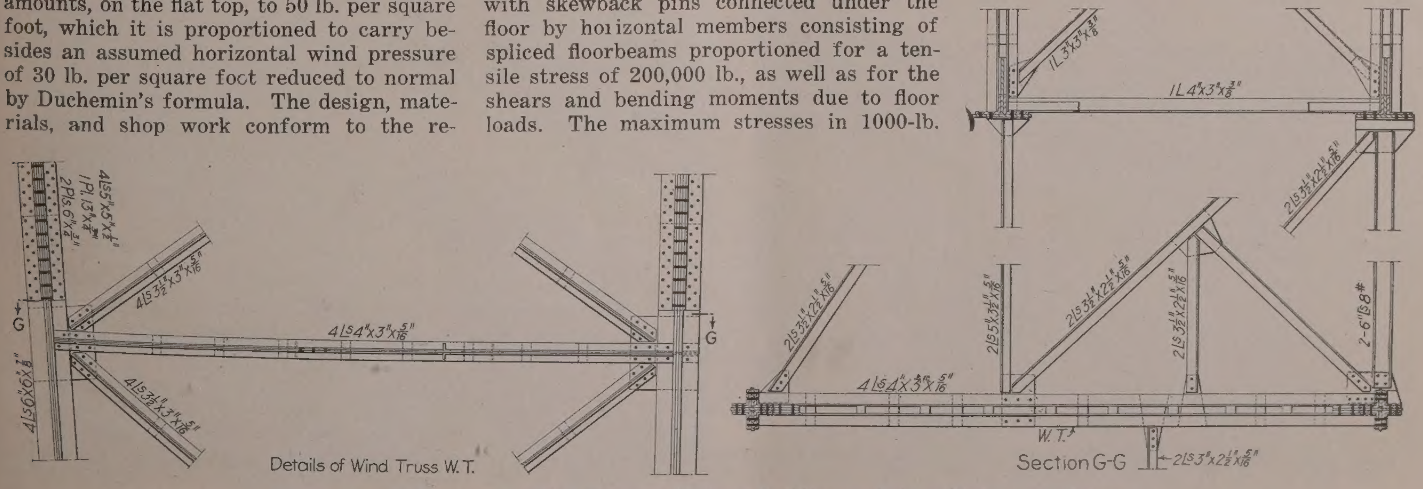
The maximum cross-sectional areas of the different members are as follows: Top chords at the haunches, two 8 x 6 x 15/16-in. flange angles, one 15 x 15/16-in. web plate, two 5 x 15/16-in. reinforcement plates; bottom chords at the haunches, two 8 x 6 x 15/16-in. flange angles, one 15 x ⅞-in. web plate, and three 18 x ⅝-in. cover plates; tension diagonals, two 10 x 11/16-in. plates; compression diagonals, two 7 x 3½ x ⅝-in. angles; and radial members, four 3½ x 3½ x 9/16-in. angles. Lighter radial members are made without pairs of angles.

At the crown the ends of the semi-trusses have solid reinforced webs receiving the stress from the top and bottom chords through convergent end sections which intersect at the 7-in. hinge pin. The latter engages interlocking jaw plates, and the web plates are cut to clear the vertical through the center pin, and allow for a considerable displacement without interference. The joints in the chords are spliced with field-riveted cover angles and web and flange cover plates. Partial reliance is also placed on the end contact of the members, which were faced with great accuracy and forced to bearing by powerful mechanical appliances before the field rivets were driven.

The outside flanges of the lower ends of the trusses are vertical and about 44 ft. above the bottom pins, where they are field-spliced to the curved haunch sections. The upper panel of this section of the truss has standard chords, but in the next two panels the width of the chord web is increased from 16 to 21 in. The lower panel has a solid web of the full depth of the truss, ¾ in. thick. In this panel the flanges converge to intersection on the skewback pin 8 in. in diameter. At the pin bearing the web is reinforced to a total thickness of 5 in. to provide for the maximum stress of 200,000 lb. The pin has full-hole bearing in the double webs of a riveted shoe bolted to a horizontal cast-steel cellular pedestal with a grouted bearing of 13½ sq. ft. on the horizontal granite foundation blocks. The truss is about 7½ ft. deep over all at the lower end, 7 ft. deep at the crown, and 15 ft. deep radially at the haunches.

### RAFTERS AND PURLINS

The rafters are supported through hitch angle connections by twelve lines of longitudinal latticed girder purlins in radial planes, which have a uniform depth of 3½

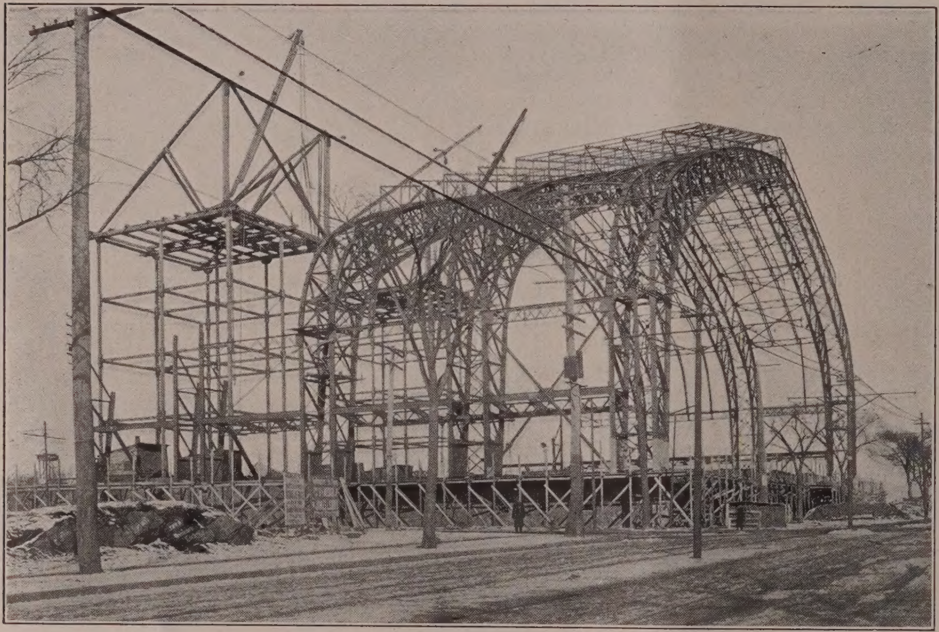


**Connection of Horizontal Wind Truss at Ends of Building to Pair of Main Arch Trusses**

ft., and are connected to the radial members in the main trusses. They have T-shaped top and bottom flanges made with vertical web plates and pairs of angles.

On each side of the roof the two lower sections of the rafters and the center section at the crown are curved, but are of the same depth and general material as the intermediate straight sections shown in the typical detail. They are 2½ ft. deep and are field-riveted through end-web plates to pairs of hitch angles in the longitudinal girders.

The lower sections of the purlins at the bottom ends have special solid web plates projecting 3½ ft. beyond the flange angles to afford field-riveted connection to the vertical members in the longitudinal girders. The curved edge of this web plate, opposite the longitudinal girder, is stiffened by a pair of flange angles, and the upper horizontal edge is stiffened by another pair of flange angles, the whole construction serving as a web member in the horizontal stiffening truss connected with the longitudinal girder at this point.



View after Erection of About 100 Feet of Roof—Monitor Frames and Bracing Assembled

### WIND TRUSSES

The wind trusses at the ends of the building extend across the full width in a horizontal plane 40 ft. above the center of the skewback pins. The outer flange is in the transverse plane of the end roof trusses and the inner chord is curved to give it a depth varying from 10 ft. at the end to 20 ft. at the center. It is 258 ft. 10 in. long, and its chords are securely riveted at the ends to the lower chords of the roof trusses, to which it transfers its horizontal thrust, a load which produces maximum stresses of + 478,000 and — 487,000 lb., respectively, in the straight and curved chords.

The chords are made of pairs of 6 x 6-in. angles from ¾ in. to ⅝ in. thick. The truss is divided into twenty-three nearly equal panels, X-braced by sets of four 3½ x 3-in. angles, which in the members normal to the chords are composed of four 4 x 3-in. angles. The truss is supported from the roof truss intermediately by vertical suspenders, each made of two pairs of 2 x 3½-in. angles latticed together and riveted to clip angles on the lower chords of the end roof truss and to web plates in the vertical members of the horizontal truss. The vertical suspenders, which are 10 ft. in depth, also have the function of bracing the glazed portion of the ends above the brick walls. The straight chord of the wind truss is in the same plane as one flange of the suspender, the other chord of the wind truss is beyond the other flange of the suspender and is braced to it by an inclined strut.

Pilcher & Tachau are the architects for the building and the Gunvald Aus Company is the consulting engineer. The contractors for the foundations were Patrizzio & Hendrickson. The general contract for the building was awarded to the Conners Brothers Company. The contract for the 7600 tons of structural steelwork, including the floors and the remainder of the building, was awarded to the Owego Bridge Company. The structural steel was fabricated by the Cambria Steel Company and is being erected by the Pittsburgh Construction Company.

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## Guarantee and Other Features of the New York Road Specifications

### Three-Year Maintenance Requirement in Brick, Stone and Asphalt Block Contracts—No Guarantee for Concrete and Macadam

THE first specifications issued by the New York State Commission of Highways since the discussion arose as to the commission's past policy contain a number of novel features. The much-talked-of guarantee clause appears in a highway repair contract proposed in connection with the letting shortly to take place, under which bids will be received only for brick, asphalt-block, stone-block, cement concrete and water-bound macadam. No guarantee will be exacted on concrete and water-bound macadam, but brick, asphalt-block and stone-block highways must be guaranteed for three years. Inquiry as to the reasons for the discrimination develop the reply that it was thought impossible to obtain guarantees on concrete and water-bound macadam.

These are the guarantee clauses:

"The contractor in consideration of the moneys to be paid and received for the construction of such work hereby expressly covenants and agrees for a period of three years to guarantee and maintain the parts of the road hereinafter mentioned and under the following conditions:

"The base of the road when laid shall be accepted in writing by the State Commission of Highways, and after such acceptance in writing is given by the State Commission of Highways the contractor then covenants and agrees to guarantee and maintain all that part of said road over the accepted base for a period of three years from the final acceptance thereof by the State.

"The contractor further agrees to promptly make and execute free of charge any and all repairs to said part of said road and renew all such materials as aforesaid as may become necessary from ordinary and legitimate wear and tear, from natural causes, or from defective materials, and to restore said portion of said work to the proper grade if it falls below it at any place, and remedy all such defects as may disclose themselves during said period of three years, even if the repairs are not or cannot be made during the said term. In case of the failure of the contractor so to make the required repairs and renewals the State Commission of Highways may have the work done and any expense may be paid under the sum retained by the State under this contract, and that being insufficient or there being none on hand the contractor and the surety company on his bond shall make good the deficiency. The State Commission of Highways shall decide when work is in need of repairs during the time of the guarantee. This guarantee and maintenance requirements will apply only to that part of the work for which it is expressly stated herein that the contract price shall cover the guarantee and maintenance for a period of three years.

"A sum equal to 5 per centum of the contract price for that part of the work for which guarantee is required will be retained out of the moneys accruing to the contractor for a period of one year after the completion and acceptance of the work."

The cement-concrete specifications call for a 1:1½:3 mixture and for expansion joints every 30 ft. of the length of the road. In the asphalt-block specification it is provided that "the asphalt cement shall be composed of natural or oil asphalt, and asphaltic oil, as approved."

### BRICK AND STONE BLOCK

In both the brick and stone block pavement specifications it is provided that the grouting "shall be composed of 1 part of Portland cement and 1 part of fine, sharp, clean sand." No alternative provision is made for bituminous filler. The latter fact is of interest in connection with the recommendation of the highway advisory engineers of the Department of Efficiency and Economy, who recommended bituminous fillers for brick and stone-block pavements. This recommendation was the subject of editorial discussion in the Engineering Record of Dec. 20, 1913, page 680.

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CEMENT MANUFACTURE IN THE PHILIPPINES is under consideration, according to a recent consular report. The Rizal Cement Company has acquired property and limestone and silica deposits at Binangonan, about 30 miles from Manila, has ordered a complete outfit of machinery, and is erecting a factory.

# Collapse of Groined-Arch Roof at the Belmont Filters in Philadelphia

### One Line of Bays, 125 Feet Long, with Foundations on 7-Foot Fill, Falls after Cracks in Roof Had Been Opening for 9 Years

THE groined-arch roof of an end bay of one unit of the Belmont filtration plant in West Philadelphia, Pa., collapsed Dec. 24, 1913, necessitating the withdrawal from service of this and two adjoining filters. These three units—Filters 13, 14 and 15, shown in Fig. 1—face Monument Avenue, which runs north and south. The invert floors are built upon a fill, the maximum depth of which is about 7 ft. The failure, which involved a strip about 125 ft. long, occurred near the deepest fill and followed the lines of cracks which had started to develop as long ago as 1904.

Filter 14 consists of a series of non-reinforced vaults supported by square posts spaced 15 ft. 3 in. on centers in either direction. Before beginning the construction of the filters, about ten years ago, it was necessary to build a stone retaining wall along Monument Avenue, as the level of the street was 6 or 8 ft. below the base of the filters. The fill was placed behind the retaining wall, rolled in layers and allowed to settle during the winter of 1902. In the following spring 12 in. of clay puddle was placed before the concrete floor in the form of inverted groins was laid. It, therefore, appears that the usual precautions in compressing the fill had been observed.

As will be noted in Fig. 2, the square sections of the columns supporting the arches were separately molded and the joints between bases and tops filled with mortar.

### CRACKS NOTED IN 1904

The formation of cracks in the roofs of the three filters was noted in 1904, and in December of that year these were platted as shown in Fig. 3. A construction joint runs along the barrel of the arch in a north and south direction through the easterly bay of the three filters. The most plausible explanation of the initial trouble is that the forward section (the one toward the retaining wall) settled and tipped slightly, opening the construction joint and causing a slight vertical slip of the front section past the adjoining section. The two halves of each arch were then at some points unsupported at the center and the section along each haunch was subjected to tensile stresses. As the construction joint widened hair cracks developed, growing as settlement progressed. It is of course quite possible that temperature contraction aided in this action.

No steps to remedy the condition of the filters were taken until October, 1913, possibly because the early inspection was made from the interior of the filters and did not disclose the true danger of the cracking. Two parallel rows of supports were placed underneath the cracks, one along the line of the ventilators and the other just inside the first line of posts. The roof was also relieved of the earth fill, which was thrown away from the road and deposited upon the roof of the second bay.

### DISCUSSION OF CAUSE OF COLLAPSE

The possible influence of this additional earth load on the final collapse of the destroyed section has been given much attention by observers. It appears, however, that this consideration has no more to do with the original faulting than the blasting for a water main laid recently in Monument Avenue. The facts are that these cracks existed in 1904, that they gradually widened and lengthened, due probably to the original cause, and that at the time of the recent investigation the section was hardly more than a group of poorly connected slabs which were due to fall in a short

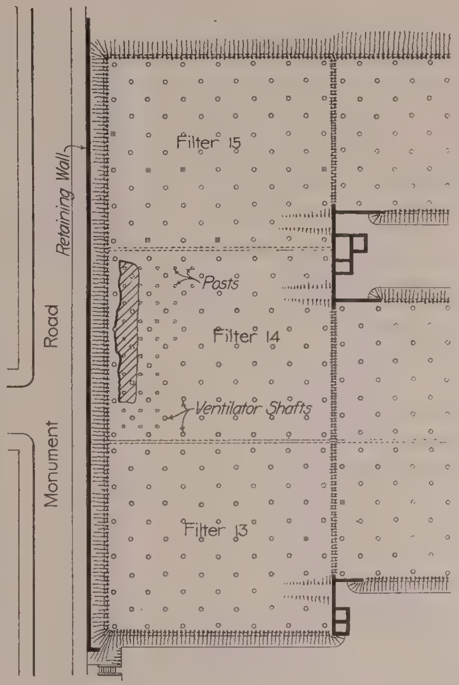


Fig. 1—Plan of Three Filters with Cracks in Roofs

Hatched area (Filter 14) shows failure.

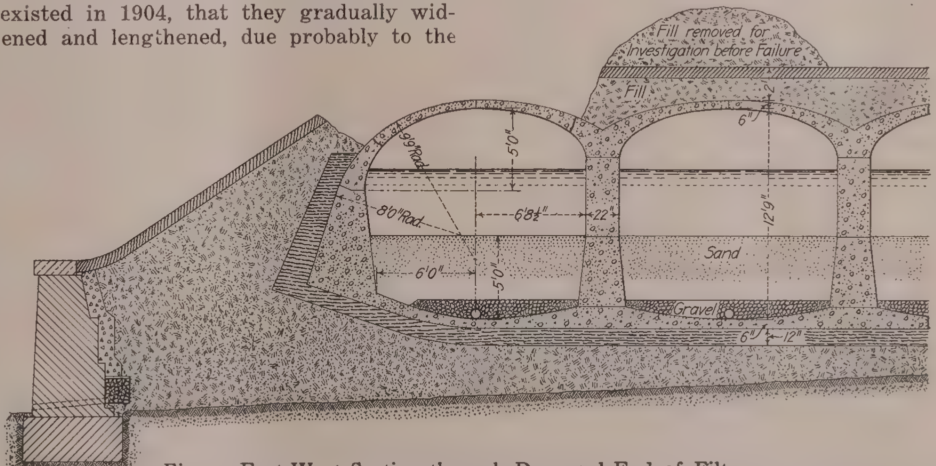
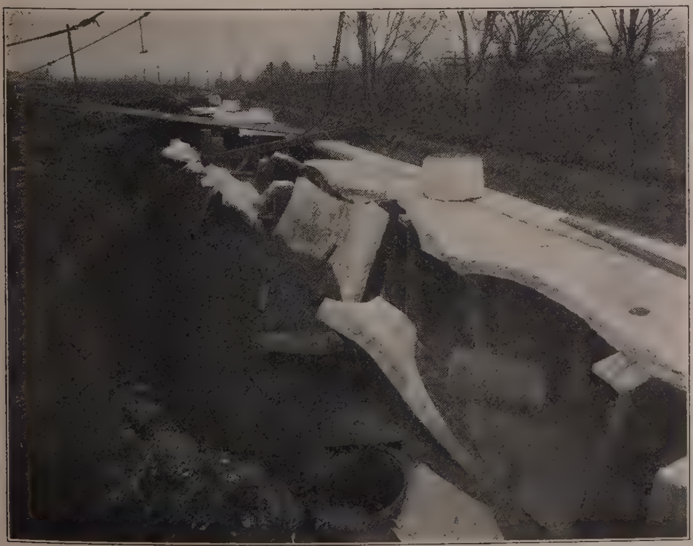


Fig. 2—East-West Section through Damaged End of Filter 14

Construction joints at arch barrels and cracks at haunches of first bay are shown. The first line of posts tipped forward when failure occurred, allowing roof of second bay to fall.



View of Collapsed Section, Facing North

View of Collapsed Section, Facing South

time from some slight shock. Sufficient proof of the realization of this condition is shown by the action of the plant authorities in calling the laborers away from the work of shoring shortly prior to the collapse. The most generally accepted reason for the original faulting is that already given—that settlement of temperature contraction opened the construction joint along the barrel of the arch, bringing the sections at the haunches into tension to withstand which the groined-arch type of roof is evidently not fitted. Lines of cracks in Filter 15, which is still standing, bear out this explanation.

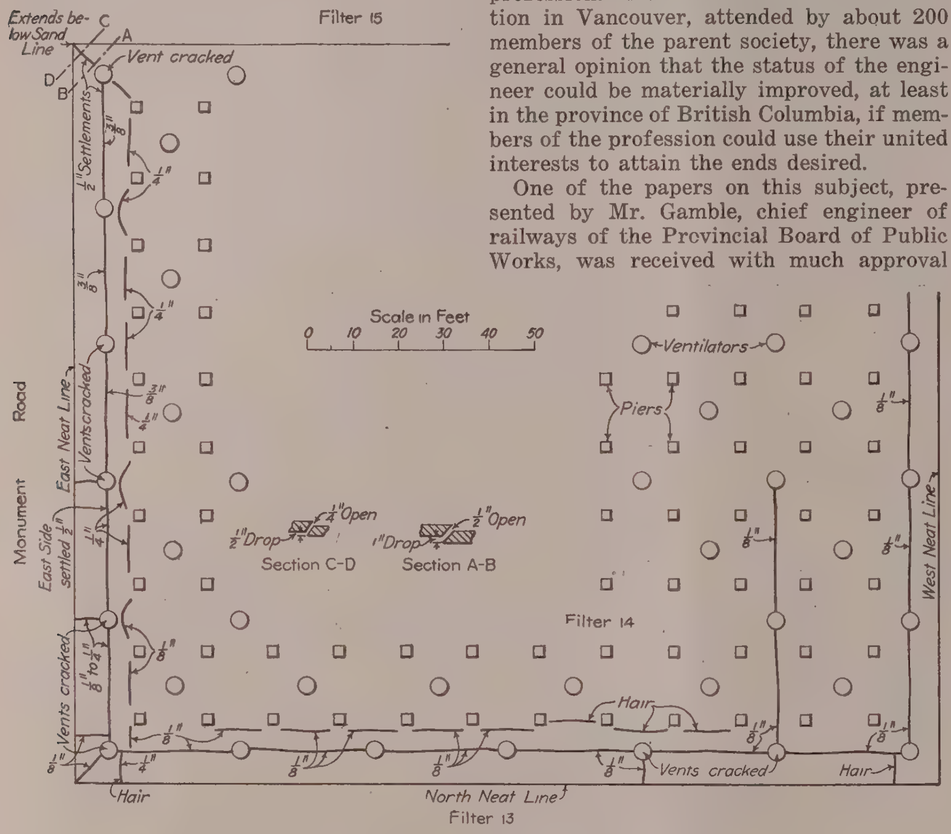


Fig. 3—Cracks Discovered in 1904 in Roof over Outside Compartments of Filter 14

### REPAIRS

The first line of posts to the west of the fallen section are standing, but they are evidently out of place, as the mortar joint at the top of each is open 3/8 to 3/4 in. on the side facing the collapsed section. The opening of these joints apparently accompanied the failure as the adjoining filters (13 and 15) do not show the same phenomenon. Timber columns and joists were placed under the adjacent vaulting as soon as possible after the accident to prevent further damage.

No measurements of the deformation of standing members of the plant have been taken with surveying instruments. The retaining wall on Monument Avenue, however, is apparently in its original position. It is not possible at present to tell whether any leakage in the floor of the filter had occurred, as the sand has not been removed. The broken sections of concrete have been taken out and the work of investigation will be carried on rapidly.

The probable method of repairing the break involves cutting shelves in the haunches of the arch at either side and substituting a reinforced concrete arch. This plan, however, has not been definitely decided upon.

## Engineering Societies and the Good of the Profession

Discussion of Plan to Form British Columbia Division of Canadian Society of Civil Engineers

DISCUSSIONS which have resulted from the suggestion that the British Columbia members of the Canadian Society of Civil Engineers form a provincial division have brought out many diverse views relative to furthering the best interests of the profession. At the recent annual convention in Vancouver, attended by about 200 members of the parent society, there was a general opinion that the status of the engineer could be materially improved, at least in the province of British Columbia, if members of the profession could use their united interests to attain the ends desired.

One of the papers on this subject, presented by Mr. Gamble, chief engineer of railways of the Provincial Board of Public Works, was received with much approval and acknowledged to be in general an expression of the feeling which prevailed among British Columbia members of the parent society. The following extracts from Mr. Gamble's paper are his suggestions of remedies for removing the disabilities under which the profession is laboring:

### THE BRITISH COLUMBIA DIVISION

"The parent body, possessing power to pass new by-laws and amend others, might very well and quite within the scope of its power increase its activities without impairing its dignity. The questions might very well be asked, 'Has the society fulfilled its legitimate functions? Has it improved the status of engineers and raised the professional standard throughout the Dominion?' The speaker is one of those members who are strongly of the opinion that the duties and responsibilities of the society are something more far-reaching and important than the reading and discussion of papers.

"The proposal to establish a British Columbia division within the parent society, clothed with a certain amount of autonomy, must appeal strongly to every member living in this province. The untrammeled spirit of the West demands it. The by-law in this respect proposed by the council of the parent society does not respond to the aspirations of British Columbia. On the other hand, if a British Columbia division were granted on the lines suggested by both provincial branches, loyalty to the parent society would be stronger than ever. It certainly will not be weakened. Civil engineers, living in this province, who up to this time have held aloof, will eagerly apply for membership, and the result will be a strong and vigorous body of trained and experienced men wielding powerful influence, taking part with lawyers, doctors and business men in the administration of public affairs. Such a condition would, without the shadow of a doubt, improve the status of the engineer and raise the professional standard. Engineers are peculiarly well fitted, on account of their training, for executive positions in connection with public works. They must not be content to act solely as advisers.

"It is to be hoped that there will be no need of forming a separate organization. The formation of a separate association in this province must be avoided if possible. This danger would be averted by the establishment on broad lines of the British Columbia division. It can be accomplished by the gradual breaking down of all opposition (such opposition being due mostly to misapprehension on the part of Eastern members) to a British Columbia division; and by the decision of the parent society to promote and encourage, not only the increase of professional knowledge, but the improvement of the status of engineers within the Dominion. The responsibilities of the parent society in the direction pointed out are very great and they should not be avoided.

### CODE OF ETHICS NECESSARY

"To improve the status of professional engineers it has been suggested by many that it is desirable to separate professional engineering, pure and simple, from commercial engineering. But there are many reasons why it is not desirable to have this done, at least in Canada. The standard of professional engineering, however, can be very materially improved if engineering and contracting companies consent to desist from giving advice, furnishing designs, specifications and estimates free of cost to the client, or to the possible client. Charging the usual fees for such services would be fair to the professional engineer who depends solely upon his profession for his livelihood. A very large number of trained engineers, dissatisfied with the comparatively small recompense received for their services, have entered or formed engineering or construction companies, but they should not forget their duty to their brother engineers. They should not underbid them by giving advice gratis.

"One of the most important and urgent necessities in connection with the future of the engineering profession is the preparation and issue of a comprehensive and strict code of ethics. Every engineer who values his reputation and the reputation of his fellow-engineers should thoroughly understand this code and become well versed in every article thereof and strictly follow its principles. He should consider it a professional asset. The code should be most carefully impressed upon engineering students in every college and school of applied science. It should contain articles inculcating the necessity and virtue of loyalty, first, on the part of the subordinate to his superior; second—and this is very important—loyalty upon the part of the superior to his subordinate; and third, that the qualities of kindness and candor should be cultivated."

# Various Phases in the Details of Timber Preservation

Abstracts of Five Papers on Treatment and Plant Methods Presented at Recent Convention of Wood Preservers at New Orleans

## Air Pumps versus Hydraulic Pumps for Injecting Preservatives

By F. J. ANGIER
Superintendent of Timber Preservation, Baltimore & Ohio Railroad

IT is the practice at most timber-treating plants to use hydraulic pumps to force the preservatives into the wood. Hydraulic pumps may have some advantages over the use of compressed air, but they also have some disadvantages, which led the Baltimore & Ohio to decide in favor of the air pump in designing the plant in Green Spring, W. Va. In the application of the air-pressure system at the Green Spring plant, there are employed two small upright tanks, called "pressure-measuring-drain" tanks, deriving their descriptive title from their three distinct operations—for pressure, measuring, and drain. In the case of the ordinary pump method, at least two tanks would be required, one for pressure and measuring, and one for drain.

[The paper describes in detail the working of the system, which was briefly outlined in a description of the Green Spring plant by Mr. Angier in the Engineering Record of May 24, 1913, on page 572.]

### Advantages of the Air Pump

The advantages of the air pump are as follows:

Only one tank is required for each retort, that tank serving in the triple capacity of pressure, measuring, and drain tank.

One air pump is ample for three retorts, while one hydraulic pump is required for each retort.

The maintenance of one air pump is much less than three hydraulic pumps, and is decidedly cleaner. The air pump requires less attention, and lessens the cost of packing, lubricants, valves, valve seats and plungers.

An air pump is a necessity in plants using hydraulic pumps for blowing back solution, unless those plants are equipped with expensive underground receiving tanks. In the latter case an air pump can be dispensed with in lieu of a large oil pump for pumping solution back into the working tank. The underground receiving tank is more expensive in operation than the air pump.

One air pump can be operated on two or more retorts at the same time without deranging the gage readings. This is not practicable with hydraulic pumps.

It is practically impossible to maintain a steady and constant pressure on a charge of timber with a hydraulic pump, even though it is equipped with relief valves, while with the air pump this is easily accomplished.

The amount of steam required to operate one air pump is not more than would be required to operate three hydraulic pumps.

The initial cost of installing the air-pump system is a trifle more than for the hydraulic pump system, but the maintenance is less, and in the long run air is more economical. The tables will give some idea of the relative first cost, which may vary one way or the other, depending on local conditions.

TABLE 1—COST OF AIR-PUMP SYSTEM

| | |
|---|---|
| 1 air pump (capacity 8 cu. ft. of compressed air per minute at 175 lb. gage pressure) | $1,200 |
| 3 pressure-measuring-drain tanks | 2,000 |
| Piping, valves, etc. (estimated) | 400 |
| Total cost of air-pump system | $3,600 |

TABLE 2—COST OF HYDRAULIC-PUMP SYSTEM

| | |
|---|---|
| 3 hydraulic pumps | $1,000 |
| 3 measuring tanks | 900 |
| 2 drain tanks | 400 |
| 1 low-pressure air pump | 500 |
| Piping, valves, etc. (estimated) | 600 |
| Total cost of hydraulic system | $3,400 |

With hydraulic pumps there are more machinery to care for, more tanks to look after and more piping and valves to maintain. There is also more work for the engineer, and unless everything is compactly arranged the engineer will require an assistant. With the air pump one man can easily look after the entire operation with greater satisfaction and with better results.

## Effect of Varying the Preliminary Air Pressure

By CLYDE H. TEESDALE
Forest Products Laboratory, Madison, Wisconsin

THE results presented in this paper are based on a group of experiments, the object of which was to obtain data on the following points:

1. The effect of varying the air pressure applied prior to impregnation with creosote upon the following features of treatment: (a) Rate and amount of absorption during the filling and pressure period; (b) amount of recovery during release of pressure (called "kickback," which is understood to mean the amount of oil recovered from the ties while the oil pressure is being released from its maximum to atmospheric); (c) amount of recovery due to drip and a final vacuum; (d) uniformity of treatment, indicated by the variation in absorption of individual ties from the average of the charge, and (e) diffusion of preservative through the wood.

2. The transmission of air pressure, vacuum and oil pressure in the wood.

### Tests

The experiments consisted of a series of runs made on hard-maple, red-oak, hemlock, and loblolly-pine crossties. The maple, hemlock and red-oak ties, of which 500 were used, all hewed, divided about equally between the three species, had been seasoned at least eighteen months before treatment. The loblolly-pine ties had been cut at least six months; 200 of these, all sawed, were furnished.

The tests consisted of forty-eight runs under various conditions. Eleven ties were used in each run and each species was treated separately. The temperature of the oil, the maximum pressure and all operations of filling the cylinder, emptying, draining and weighing the ties were held as similar as possible in all of the runs. In addition, the absorption of oil by the ties at the end of the pressure period, but before releasing the pressure, was as near 12 lb. per cubic foot in each run as possible.

### Conclusions

The following are brief statements of the results indicated by the experiments:

1. The absorption of preservative during the filling and heating period (initial absorption) was least when no preliminary vacuum or air pressure was used, and greatest when high preliminary air pressures were used. The time required to fill the cylinder varied from about twenty-three minutes when preliminary vacuum was used to about forty minutes when a preliminary air pressure of 75 lb. was used. Loblolly pine was an exception.

2. Preliminary air pressures did not materially increase the time of the oil-pressure period necessary to secure the required absorption in maple, loblolly pine, or red oak. In hemlock high pressure materially increased the time of treatment.

3. Loblolly pine required the shortest pressure period to reach the desired absorption. Maple ranked next in order, then red oak. Hemlock required, comparatively, a very long pressure period.

4. The smallest "kickbacks" were obtained when a preliminary vacuum was used; the highest when high preliminary air pressures were applied.

5. Final vacuum had no marked influence on the amount of drip recovered, except in the case of loblolly pine. It hastened recovery, however, and enabled oil to be saved that would otherwise drip on the ground. In either case the amount finally left in the ties in the majority of cases was nearly the same. The use of final vacuum rendered the timber cleaner to handle. Final vacuum resulted in a heavy recovery from seasoned loblolly pine when preliminary vacuum and preliminary atmospheric pressure were used.

6. The distribution of preservative through the wood was apparently not influenced by preliminary vacuum or air pressure.

## Mechanical Handling of Timber at Creosoting Plants

By LAMBERT T. ERICSON
Assistant Superintendent of Port Reading Creosoting Plant

THERE are a number of items to be considered in devising the best and most efficient method for handling crossties and heavy timbers at timber-preservation plants. Although each plant and location presents special problems and difficulties peculiar to themselves there are a number of conditions common to all. Besides the common conditions of limited areas for storage and the receipt of great quantities of material in a short space of time there is the co-ordinate difficulty of obtaining the necessary labor to meet the fluctuating demands. The problem of keeping down the cost of handling comes in at this point. Where manual labor is depended upon entirely it is necessary to have men skilled in their work in order to keep the cost down to the regular piecework rate. And when unskilled men are used the cost of handling goes up very materially.

Locomotive cranes to switch and unload the materials have proved very economical and successful under certain conditions. They can displace a locomotive in doing the shifting, can pile twice as much material in the same area, at less than half the cost of the manual method, and can attain great speed. The number of men required is very small in comparison with the manual method, and consequently the force necessary for the work becomes very nearly constant, no matter how much the receipt of material fluctuates, as there is always need for the men on other work when the lull comes.

### PORT READING PLANT

The Philadelphia & Reading Railway and the Central Railroad of New Jersey, at their timber, preservation plant at Port Reading, N. J., are using locomotive cranes. The plant, being located on Staten Island Sound, has deep-water connections, and most of the timber comes in by schooners and steamships direct from the South. The storage yard is adjacent to the docks. Special flat cars, of which there are twenty-five, kept for the individual use of the treating plant, are used for transferring the material from the vessel to the yard. That number is sufficient, under ordinary conditions, to keep five vessels unloading continually. Each car holds an average of 190 standard ties, which are loaded in slings of thirty or sixty, according to the height of the piles and the size of the crane doing the stacking. The plant uses four locomotive cranes, two of 30-ton capacity, one of 20-ton, and the fourth of 10-ton capacity, the two 30-ton cranes ordinarily doing the stacking of ties and switch timber.

The slings are picked up and landed on the piles, where they are leveled off by hand at a piecework rate. Switch timber is handled in much the same manner. Large-dimension timber and piling are handled and sorted out by the 10-ton crane. Cross-ties are piled in rectangular piles 51 ft. long, vertical at each end, to an average height of 25 ft. Each pile contains an average of 1850 ties. Switch timber is either piled, with the lengths varied, and all running one way, to an average height of 21 ft., or is lifted off the cars to the ground by the crane, sorted into lengths by hand, made into slings, and then picked up by the crane again and put on the piles.

### CAPACITIES AND COSTS

The 20-ton crane is kept busy unloading the treated material from the trams into cars for shipment. This crane picks up the material, a tram load at a time, and deposits it in the car. Coal cars and gondolas only are used, there being a large supply of both kinds to draw from in this district. This crane loads for shipment between 5000 and 6000 ties per day. Each 30-ton crane can shift and stack an average of from 3500 to 4000 ties per day, or 150,000 ft. b.m. of switch timber.

Including the cost of shifting the cars from the docks to the yard, the cost of stacking the ties with this method amounts to an average of $0.008 per tie; the cost of stacking switch timber of promiscuous lengths together, an average of $0.35 per 1000 ft. b.m. The cost of loading treated ties from the trams for shipment, with the crane, amounts to an average of $0.0045 per tie. In these calculations the cost of operating the crane, including operator, has been figured at $1 per hour. This allows for interest on investment, depreciation, coal, oil, etc.

By close attention to details it has been possible to cut the cost very materially, and it will be cut still further as the system becomes more thoroughly established.

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## Methods of Separating Water from Creosote Oil

By THOMAS WHITE
Assistant Manager of American Creosote Works

IT is practically impossible to obtain creosote oil entirely free of water, owing to the origin of the oil. After the purchase of oil almost water free, leaks in the steam coils of the storage and treating tanks and cylinders caused by the acids of the oil or the timber, steam condensation and moisture from the timber in the cylinders, or, if the plant uses underground tanks, seepage of ground water into these through open seams or pinholes—all tend to let water into the oil. While some water from rainfall becomes mixed with the oil if in open tanks, this can be siphoned off directly from the top. This free water is really an asset in that it affords positive fire and lightning protection.

This water in the oil is readily got rid of by the use of the steam coils in the tanks which are brought into everyday use, but not so easily if kept cold in a reserve storage tank which is only drawn on at wide intervals. In this cold condition the contents will stratify in the tank into three main horizontal zones, each of varying depth, depending upon the gravity of the oil. The top zone will be free water floating over the middle one, which is an emulsion, while the bottom zone will contain the least amount of water. The water in this bottom zone is usually such a small portion that it will hardly be troublesome. It is the water in the middle zone which is most difficult to eliminate.

### OPEN-TANK AND STILL METHODS

Heating the contents to the boiling point in an open tank with steam coils will create an upward circulation, which will continue after the steam has been shut off and until the liquid thoroughly cools. Since the water is lightest it will rise to the top, where it can be readily drawn off. If the tank is provided with an agitator, the operation will be greatly facilitated, causing quicker evaporation and stratification.

The other method of water extraction, which is the better, though not always justifiable at the creosoting plant, is the still method. Of the two styles of stills, the horizontal and the vertical, the latter is probably preferable for water removal, although the horizontal still seems to be used almost universally in the United States for tar distillation. Even from the viewpoint of construction and maintenance the vertical one is more favorable in that it would not require a separately built smokestack and when burned out at the bottom could be replaced easily. It should induce better evaporation in that there would be a more direct and quicker circulation of the gases. While the heating surface appears less, this may be increased by the use of vertical fire flues, which would also serve as smokestacks. There would also be less tendency to foam, which means that the operation could be rushed more with less danger of the oil boiling out of the still.

The open-tank method would probably evaporate at least 1 per cent of water per day while the liquid was kept heated above 180 deg. Fahr., not to mention the free water which would separate and rise to the top. The still method would probably evaporate about 1 per cent of water per hour. The still would require extra fuel and attention, whereas the open-tank coils would tax the main boiler and its fireman very little more.

There are numerous other methods of water extraction, such as the centrifugal and vacuum processes, some of which might be preferred in individual cases.

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## Treatment According to Conditions of Use and Exposure

By E. L. POWELL
Vice-President of American Creosote Works

FEW engineers have paid as much attention to wood preserving as they should, relying upon the many books and papers that have been written upon the subject for their knowledge when occasion arises. Much of the printed information on this subject is valueless. Hence the wood-preserving company is usually in a far better position to draw up the specifications than the engineer, and it is of great importance that the two work together constantly to secure the best results. The wood preservers should control treating methods, at least to the extent of seeing that no material is treated under improper specifications when the conditions under which the material is to be used are given proper consideration.

The amount of preservative required is directly affected by the kind of soil, whether wet or dry, and climate in which the timber is to be used, as well as by the character of the timber to be treated and the mechanical wear to which it will be subjected. Ties to be used in hot, wet countries require a different treatment from those for a cold climate or arid region. The treatment for piling and lumber should vary also, and the treatment of such timber to be used in teredo-infected salt water must be radically different from timber used in fresh water, swamp land or cold or arid regions.

It should be possible for the treating company to secure full information concerning the conditions under which the material is to be used, and, if necessary, the company should refuse the business unless the buyer is willing to have the material treated properly and sufficiently.

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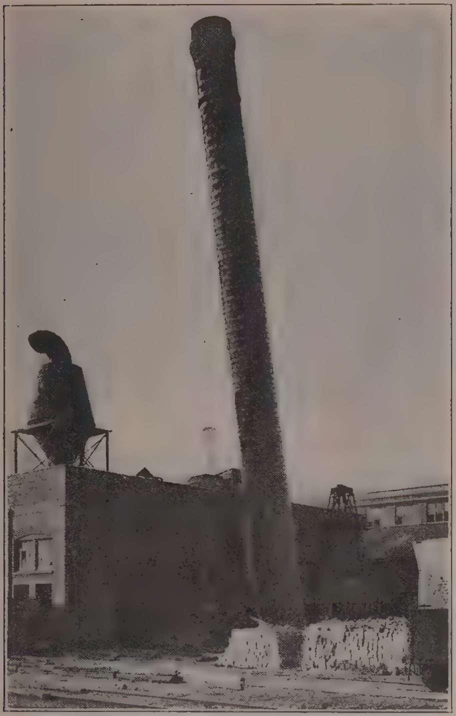
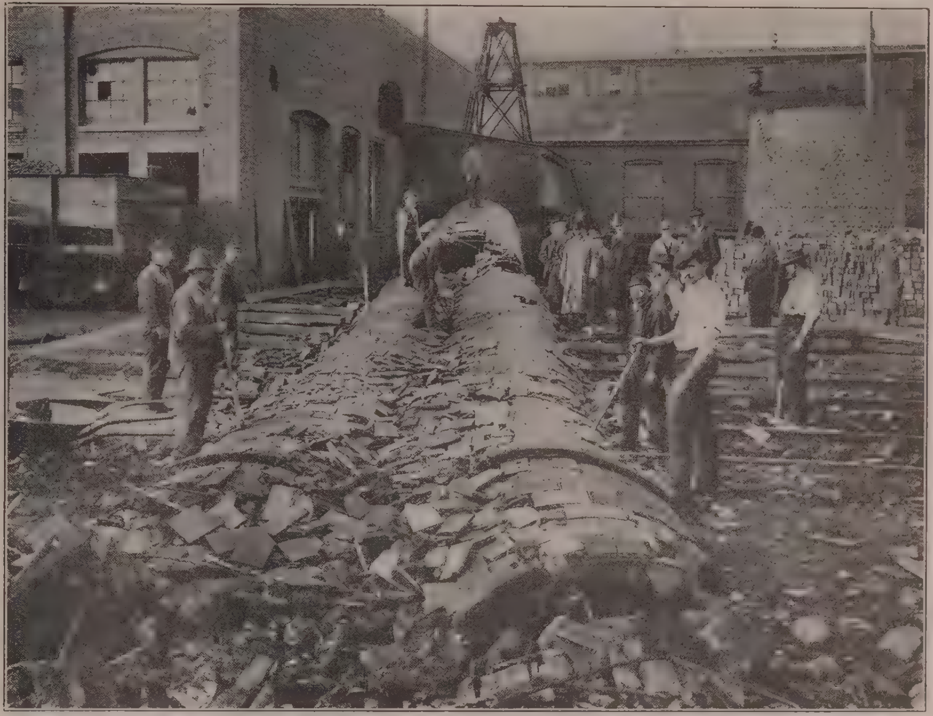
STEAM RAILROADS IN WISCONSIN are valued at $348,028,000 by the State Tax Commission, according to the preliminary assessment. This is an increase of $21,775,000 over the final assessment of a year ago.


Chimney Starting to Fall


After the Fall—Showing How Tile and Concrete Structure Was Shattered

## Felling a Combined Tile-and-Concrete Chimney

Stack in Restricted Quarters Made to Fall within 1 Foot of Desired Place

ONE of the first combined tile and reinforced-concrete chimneys to be destroyed was felled on Oct. 18, 1913, at Thirty-first Street and Kedzie Avenue, Chicago. It belonged to the Liquid Carbonic Company and was erected four years ago by the Wiederholt Construction Company. Expansion of the plant demanded a larger chimney farther away from the existing building to permit of extension.

Owing to the restricted quarters the owners wished to fell the chimney across three switch tracks within very narrow limits at the outer end. This result was accomplished by the contractor within 1 ft. of the desired position. At 1 p. m. Friday he received the contract and Saturday at 3.08 p. m. the men working at the base were notified to run. At 3.22 p. m. the chimney lay on the ground.

### PREPARING FOR FALL

In preparing for the fall four rows of the 9-in. tiles at the ground level and the concrete back of them were cut away for slightly more than one-half the diameter of the stack. Fourteen 1⅜-in. reinforcing bars in the opening were cleaned of the cement, slightly nicked with a chisel and then burned off in thirty minutes by an oxyacetylene outfit. Final starting of the chimney consisted in striking the middle tiles with a sledge opposite each other adjacent to the cut.

In falling, the stack rotated about a center line at the top of the cut, crushing one tile and the concrete back of it on each side. At the time the crushing was heard cracks in a diagonal direction upward and backward appeared. The back of the chimney parted on this line about 6 ft. from the base. The 1⅜-in. vertical reinforcing bars which extended into the base and up into the chimney for about 8 ft. above ground pulled out of the chimney concrete and whipped back within 1 ft. of the vertical position. For 25 ft. from the base the circular form was retained, while the remainder presented a double-barreled appearance with many of the tiles intact. Ten men with sledges immediately started at work to break up the portions not shattered and by 10 a. m. Sunday the débris had been removed.

Provision to protect the tracks consisted of old ties placed end to end each side of the rails. The impact did not harm the rails, but it drove the ties under them into the earth about 6 in., pulling all of the spikes in the 15-ft. width which the felled chimney occupied.

Mr. Peter Drolshagen, chimney expert, of Aurora, Ill., was the contractor.

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## Mount Rainier 14,408 Feet High

Exact Elevation Determined by Engineers of U. S. Geological Survey after Hazardous Ascent

THE height of the summit of Mount Rainier, Washington, has been determined by the U. S. Geological Survey to be 14,408 ft. above mean sea level. This elevation now officially displaces the former supposed height of the mountain of 14,363 ft. and accords to Mount Rainier the distinction of being the second highest mountain peak in the United States, Mount Whitney, California, being the highest. The topographic survey of Rainier Park was begun by Mr. F. E. Matthes, continued in 1911 by Mr. Matthes and Mr. George R. Davis, and finished in 1913 by Messrs. C. H. Birdseye, W. O. Tufts, O. G. Taylor, and S. E. Taylor.

### TERRIFIC BLIZZARD

In the mapping of the summit of the mountain a terrific blizzard was encountered; in fact, two ascents of the upper portion of the mountain were necessary. The first ascent of the upper 4550 ft. was begun at 5 a. m. Aug. 16, and dawn broke with every indication of developing into a beautiful day. On reaching the summit the men encountered a terrific gale, clouds enveloped the mountain, preventing observations, and by noon snow began to fall. A descent was attempted, but the party became hopelessly lost in a labyrinth of crevasses, the storm developing into a blizzard.

### REFUGE IN CRATER

To descend further was impossible; to remain was suicide. Consequently a return to the crater was ordered, and the men reached it after a two hours' climb, utterly exhausted and nearly frozen. Here they sought shelter in one of the steam caves, where, during the long night, they were thoroughly steamed and half frozen in turn. Strenuous measures were employed by the men to keep from falling asleep and freezing to death. As it was, their fingers and ears were badly frozen. Finally, with a rising barometer, they succeeded in descending 9000 ft. to a temporary camp, making the descent in three hours. Here they recuperated and prepared for another ascent, which was accomplished on Aug. 20, the start being made at 1 o'clock in the morning. Good weather was encountered and the mapping of the entire summit was finished.

"If anyone thinks that American glaciers are play glaciers, or that the weather which may be encountered at the summit of Mount Rainier in August is uniformly balmy and springlike," said Mr. Birdseye, whose fingers and ears were badly frosted, "let him climb Mount Rainier during one of its summer blizzards. The steam caves in the crater are not the pleasantest places imaginable to spend the night in, but had they not been there not one of us would be alive to-day to tell the tale."

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FIREPROOF WOODEN SHINGLES are being made in the forest products laboratory of the University of Wisconsin at a cost of $15 per thousand. The method consists in forcing into the wood, under pressure, such chemicals as ammonia sulphate and ammonia phosphate. It is claimed that the new process is commercially practicable, and extended experimenting is expected to lower the cost.

Combination Station at Fair-Sized Town

Five-Span Deck Bridge over Catawba River

# Features of Piedmont & Northern Electric Lines

## High-Grade Trolley System for Passengers and Freight Connecting Various Cities in North and South Carolina

THE Piedmont & Northern Lines, comprising the Piedmont Traction Company and the Greenville, Spartanburg & Anderson Railway Company, constitute a projected high-class electric railroad from Greenwood, S. C., to Durham, N. C., a distance of about 300 miles, passing through the towns of Belton, Greenville, Spartanburg, Gastonia, Charlotte, and on to the north on a location not yet determined. The sections between Greenwood and Greenville, 60 miles, and between Gastonia and Charlotte, 24 miles, have been completed and are in operation. The Greenville-Spartanburg link is under construction and will be put in operation within a few months.

The country traversed is agriculturally rich. An abundance of water power has made great manufacturing development possible. Because of the great traffic possibilities and the competition of existing steam railroads it was determined to use first-class construction throughout. The maximum gradient was fixed at 1 per cent, compensated 0.04 per cent per degree of curvature. Except for three 8-deg. curves and one 12-deg. curve in restricted locations, nothing sharper than 6 deg. is being used. The whole road is on private right-of-way, located after numerous routes had been carefully investigated.

Between Greenwood and Greenville the grading averaged 25,000 cu. yd. per mile; on the other sections it has run double that figure. Most of the material encountered has been earth, but there has been some very hard rock. The large cuts have been made mostly with steam shovels, the spoil being hauled with dinkey trains and dumped from temporary trestles. The profile and alignment diagram of the line in the vicinity of the Enoree River crossing is typical of the heaviest work.

### ROADBED SECTIONS

The single-track roadbed sections are 18 ft. wide on fills and 20 ft. in cuts. Earth cuts have slopes of 1 to 1. The track is laid with 80-lb. A. S. C. E. rail with 24-in. Bonzano joints, on oak ties, ballasted with sand, cinders, crushed rock or a partly decomposed granite taken from some of the cuts. Most of the special track work has been laid with manganese centers.

All bridges are designed for Cooper's E-55 loading. There are three principal river crossings, in each of which 150-ft. riveted deck trusses have been used. Typical of these is the Catawba River bridge, which is shown in an illustration. For smaller waterways and ravines steel viaducts have been used, usually with 30 and 60-ft. spans. Masonry has been used almost entirely. The viaducts have buried abutments, the bases at the neat line being made 0.4 of the height from the neat line to base of rail, and the front and back batters being the same. Six standard sizes of arch culverts have been utilized, the details of which conform closely to ordinary standard practice for unreinforced culverts. The structures at highway overcrossings are of a common type and built of timber, costing about 55 cents per square foot of floor area.

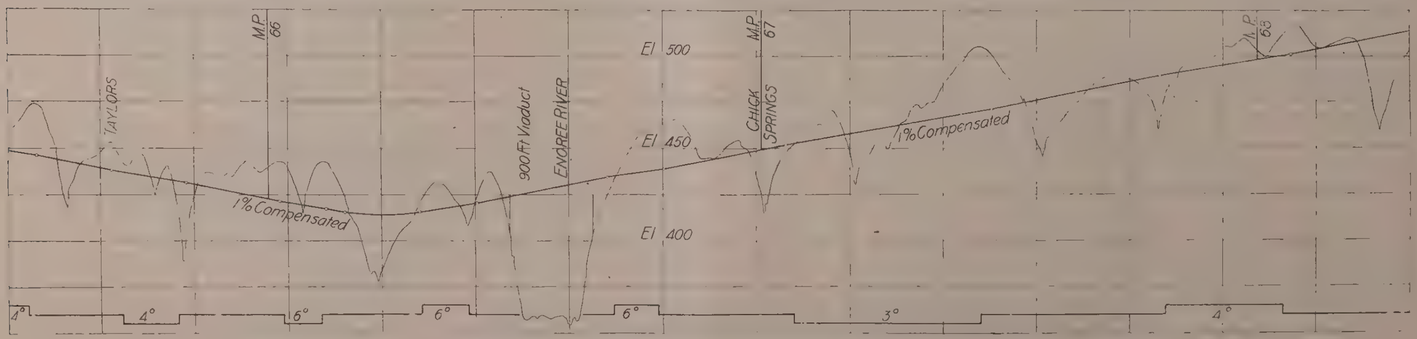
### CROSSINGS

On the lines constructed there are eight crossings under other railroads. These are all built for double track. In the first ones the abutments were placed 30 ft. apart, but this distance has been increased in later construction to 35 ft. Traffic was maintained during the work either by means of temporary detours or by supporting the tracks on pile trestles. Where trestles were made use of a track piledriver was at first employed to drive the piles; but it was found that too much time was wasted in running to sidings, and derricks were, therefore, substituted. In some cases the soil was so compact that it was impossible to drive the piles into it. To overcome this difficulty an auger was made from 12-in. wrought-iron pipe and suspended from the derrick boom with a 2-in. square rod and man-driven by long wrenches gripping the rod. By this means the holes were readily cut to the desired depth, four men usually sufficing to operate the augers. The attempt was first made to excavate only enough earth to make room for the abutments, removing the core between abutments after the bridge was erected. This plan was later abandoned in favor of doing all the excavating at once and having easier access to the concrete work.

### FREIGHT FACILITIES

Freight as well as passenger business is handled, the company claiming to render better service than the steam railroads in the locality gave prior to the construction of these lines. A view is shown of one of the combination passenger-and-freight stations. At Charlotte, the largest city on the line, a freight house 55 x 240 ft., together with a team yard with a capacity of about 66 cars, in addition to working tracks, has been provided. Steam-railroad layout standards have been used, except that No. 6 and even No. 4 frogs are permitted. Interchange tracks with steam roads are provided.

Power for the operation of the road is supplied by the Southern Power Company to substations from 15 to 25 miles apart and transmitted to the electric equipment



Typical Section of Profile and Alignment Diagram on Piedmont & Northern Electric Lines by the overhead catenary-suspension trolley system at 1500 volts. The wire is 21 ft. 6 in. above top of rail. On the city lines the voltage is 600, to which the equipment is also adapted.

The passenger cars are 60 ft. long and 9 ft. 3 in. wide, weighing 45 tons. Each is divided into four compartments—baggage, negro, main and smoker, and will seat sixty-eight people. Each car has four 110-hp motors. Express cars 40 ft. long and weighing 40 tons are similarly equipped. The freight locomotives weigh 55 tons each and are provided with four 185-hp motors; they are able to haul a train of 800 tons up the 1 per cent ruling grade. Two or more of the passenger, express or freight units can be coupled together and operated as one.

The lines have been built under the direction of Maj. Thomas B. Lee, chief engineer. Mr. W. S. Lee, vice-president, is the general executive in charge of the whole work.

## Detroit Waterworks Report

### Statistics for Period 1912-13 on Metering, Water Consumption and Bleach Treatment

DETROIT used less water in 1912-13 by 6.5 per cent than in the previous year, according to the last annual waterworks report for the year ended June 30. For the last five years the daily consumption per capita has been 167.5, 174.7, 177.3, 186.6 and 174.5 gal. The decided increase is attributed to a milder winter and cooler summer.

Metered services number 106,878, or 12.5 per cent. Income from the 38.6 per cent of water metered amounted to 43.1 per cent of the total receipts. Meter sets numbered 4532, from which is to be deducted 2037 meters removed, leaving 13,302 in service. Cost of setting, removing, repairing and testing meters was $12,700.

Beginning Sept. 15 all new buildings were required to be provided with meters, and as fast as the Board of Water Commissioners can arrange to supply the meters all water used will be metered. It is expected to reduce the per capita rate to 110 gal.

Bituminous run-of-mine coal cost $2.23 per ton. The station duty was 96,139,473 ft.-lb. Figured on the pumping-station expense the cost per 1,000,000 gal. pumped was $2.92, with an equivalent of 1.1 cents per 1,000,000 gal. raised 1 ft.

Bleach treatment of the water was started in the rebuilt emergency plant on March 21, following an unusually hard wind producing muddy water. The rate was 5 lb. at the beginning, but was gradually increased to 9 lb.

At the new pumping station the brick, stone work and tile roofing are complete. A 30-ton Northern crane was installed, one 30,000,000-gal. Bethlehem pumping engine is ready for service and two more will be put in early in 1914. These units will increase the pumping capacity by 50 per cent.

A 7-ft. brick conduit supplying water to the new station has been completed and a concrete steam tunnel connecting the two stations is under way. At the completed new boiler house a 10 x 150-ft. brick stack has been built and four 400-hp Wickes water-tube boilers equipped with Detroit stokers have been erected.

In June work was started on preliminary plans and estimated for a 200,000,000-gal. filter plant.

# Corrosion of Metals and Alloys in Contact

### Influence of Galvanic Action on Steel and Alloys in Concrete and in Water, Determined Experimentally and Results of Practical Experience

By RICHARD H. GAINES

Chemist, Board of Water Supply, City of New York

IN 1760 Johann Sulzer announced to the Berlin Academy of Science the discovery that a peculiar bitter taste is perceived when two metals are placed on the tongue and touched at their edges. The significance of this observation was not appreciated till Volta described his "Crown of Cups" in 1800. The two metals, copper and zinc, for example, in contact in the saline saliva, compose as is now known a galvanic or voltaic cell.

In order that galvanic action may occur there must be two substances which, by their contact in an electrolyte, give rise to a difference of potential so that a current flows and the electro-positive substance is dissolved away. The current here produced is named for its discoverers, and is thus distinguished from that generated from either heat or induction; but whether derived from friction or the voltaic pile the electricity is capable of producing the same effects.

#### ELECTRO-CHEMICAL CORROSION

The commonest type of corrosion is that which may be described as electro-chemical. This occurs when two metals possessing different electrical properties are immersed in contact with one another in a corrosive or conducting liquid. Owing to the difference of potential between the two bodies an electromotive force is set up, and one of the metals passes into solution. If we connect by a wire plates of copper and iron in a liquid capable of acting chemically on either of the metals, a current will pass from the copper to the iron. The copper plate, which may remain for an indefinite time unaltered within the cell, is known as the cathode, the iron being termed the anode.

The peculiarity of an electro-chemical reaction is that it consists of two parts, located separately, at the anode and cathode, yet necessarily happening together in time. The tendency toward chemical reaction, and its accompanying transformation of energy, in a cell, are measured by the difference of potential.

Where two pure metals are brought into contact under conditions that might affect the solution of both of them separately, the probability is that only one of the metals will corrode, namely, that which is at the higher potential and therefore constitutes the anode. If the initial difference of potential is slight, as in the case of lead and iron, reversals may easily take place, in which circumstance both metals will corrode to an extent proportional to the time that each has served as anode. In either case, the total corrosion is greater than that which would obtain if the plates were acted on separately, not being in metallic connection with each other. For these reasons, the rule is that metals and alloys of different properties must not be placed in contact in water or other electrolytic solution.

The same action as described above will take place in a single alloy if it is not homogeneous in composition or structure. And owing to slight variation in properties exactly the same effect is produced between two pieces of cast iron from the same foundry, or even from the same furnace charge, and the result is the greater in proportion to the difference in composition between the two pieces of iron involved. There is always more or less galvanic action between an iron screw bolt and its iron nut if exposed to water or atmospheric moisture; the moisture is sure to find its way in between, even though the screw seems to fit quite tight. Screws, nails and rivets form points of departure for the commencement and spread of rusting, and it is, therefore, essential that the points of attachment be protected in iron structures.

#### GALVANIC ACTIVITY BETWEEN STEEL AND OTHER METALS

During the past two years experiments have been in progress at the laboratory of the New York Board of Water Supply to determine the loss suffered from corrosion by steel and other metals when in contact under different conditions, and incidentally to observe some of the phenomena of galvanic action.

*Corrosion in Concrete.*—In the first series of experiments specimens of the metals listed in Table 1 were weighed and embedded singly and in contact in damp concrete and allowed to remain therein for two months. At the end of the test period the concrete blocks were broken up and the metals taken out, carefully cleaned, dried and reweighed, the loss in weight representing the amount of corrosive action in each specimen.

TABLE 1—CORROSION IN CONCRETE, SINGLE SPECIMENS, WEIGHT IN GRAMS

| Metals | Jan. 2, 1912 | Mar. 4, 1912 | Grams loss, 2 mo. | Loss in grams per sq. ft. |
|---|---|---|---|---|
| Manganese bronze | 73.6655 | 73.6475 | 0.0180 | 0.32 |
| Steel | 39.1556 | 39.1481 | 0.0075 | 0.135 |
| Lead | 92.3806 | 91.7146 | 0.6660 | 11.99 |
| Copper | 73.7630 | 73.7272 | 0.0358 | 0.64 |
| Monel metal | 62.9667 | 62.9646 | 0.0021 | 0.04 |
| *Metals in Contact* | | | | |
| 1— Steel | 37.0380 | 37.0270 | 0.0110 | 0.20 |
| 1— Manganese bronze | 70.6864 | 70.6700 | 0.0164 | 0.30 |
| 2— Steel | 38.1746 | 38.1700 | 0.0046 | 0.08 |
| 2— Lead | 90.0399 | 89.5408 | 0.4991 | 9.08 |
| 3— Steel | 38.8055 | 38.8031 | 0.0014 | 0.03 |
| 3— Copper | 70.1913 | 70.1348 | 0.0565 | 1.04 |
| 4— Steel | 38.6396 | 38.6271 | 0.0125 | 0.23 |
| 4— Monel metal | 60.1092 | 60.1074 | 0.0018 | 0.30 |
| 5— Steel | 34.5625 | 34.4626 | 0.0999 | 2.48 |
| 5— Lead | 83.8596 | 83.5163 | 0.3433 | 6.77 |
| 5— Copper | 68.9752 | 68.9626 | 0.0126 | 0.31 |
| 6— Steel | 34.7072 | 34.8026 | 0.0676 | 1.68 |
| 6— Fiber | ........ | ........ | ...... | .... |
| 6— Copper | 64.1247 | 64.1122 | 0.0125 | 0.31 |

The resulting losses show but slight differences when in contact and alone, and, therefore, give no positive evidence of electrolytic action when the metals are coupled in concrete. With the exception of the lead the corrosion loss of all the metals was negligible, that of the Monel metal almost nil.

The action of the lead corresponds with what has been observed by others and shows that this metal may suffer very appreciably in lime or cement mortar. The corrosive action in this case is purely solvent in character, due to the alkali, and no surface coating is formed to hinder progressive deterioration. The metal specimens all presented about the same appearance when taken out of the concrete as when put in.

*Corrosion in Water.*—After the first series of tests was completed the same specimens, singly and in contact, were placed in Mason fruit jars freshly filled with Croton water. The jars were then sealed and put on a shelf in the laboratory, where they remained about 19 months. At the end of this period the specimens were taken out of the jars and carefully cleaned, dried and reweighed. The losses due to corrosive action are given in Table 2.

TABLE 2—CORROSION IN WATER, SINGLE SPECIMENS, WEIGHT IN GRAMS

| | | Mar. 4, 1912 | Oct. 3, 1913 | Loss or gain, grams, 19 mo. | Loss, grams, per sq. ft. |
|---|---|---|---|---|---|
| | Manganese bronze | 73.6475 | 73.6971 | +0.0496 | ..... |
| | Steel | 39.1481 | 36.9767 | —2.1714 | 39.08 |
| | Lead | 91.7146 | 91.7591 | +0.0445 | ..... |
| | Copper | 73.7272 | 73.7254 | —0.0018 | 0.032 |
| | Monel metal | 62.9646 | 62.9554 | —0.0092 | 0.17 |
| | *Metals in Contact* | | | | |
| 1— | Steel | 37.0270 | 35.7425 | —1.2845 | 23.12 |
| | Manganese bronze | 70.6700 | 70.6822 | +0.0122 | .... |
| 2— | Steel | 38.1700 | 36.9922 | —1.1778 | 21.20 |
| | Lead | 89.5408 | 89.3314 | —0.2094 | 3.77 |
| 3— | Steel | 38.8031 | 37.6435 | —1.1596 | 20.87 |
| | Copper | 70.1348 | 70.1522 | +0.0174 | ..... |
| 4— | Steel | 38.6271 | 37.7372 | —0.8899 | 16.02 |
| | Monel metal | 60.1074 | 60.1108 | +0.0034 | ..... |
| 5— | Steel | 34.4626 | 33.2073 | —1.2553 | 22.59 |
| | Lead | 83.5163 | 83.4896 | —0.0267 | 0.48 |
| | Copper | 68.9626 | 68.9684 | +0.0058 | ..... |
| 6— | Steel | 34.8026 | 34.4543 | —0.3483 | 6.27 |
| | Fiber | ...... | ...... | ..... | ..... |
| | Copper | 64.1122 | 64.1047 | —0.0075 | 0.14 |

In each of the foregoing series of experiments (i.e., in damp concrete and in Croton water) specimens numbered 1, 2, 3 and 4 were in absolute metallic contact, flatly bolted together by iron machine screws and nuts. Specimen 5 consisted of three metals flatly bolted together, but the connecting bolts were insulated from the plates by fiber collars and washers. Specimen 6 was made up of two metals separated absolutely from galvanic contact by a fiber plate but held together by bolts which were also insulated from the plates by fiber collars and washers.

### RUSTING

When the specimens were taken out of the jars it was found that wherever water had had free access to the steel plates, in every instance the exposed surfaces were covered with a slimy deposit of iron rust, which had also formed over the connecting bolts in large burs. The rust was black from a deposit of carbon near the steel, and in nearly every specimen the laminar rusting due to mill scale was apparent. The connecting screws and nuts had also been notably attacked, but no more difference in the degree of corrosion was observable where the connectors had been insulated by fiber collars and washers, as in specimen 5 where the metals were not in galvanic contact, than where the contact was complete, as in specimens 1, 2, 3, and 4.

After being cleaned, all of the steel specimens presented the appearance of having rusted uniformly, with no marked evidence of local action. The manganese bronze, lead and copper specimens, whether in contact or alone, were only slightly tarnished when taken out of the jars, while the Monel metal was practically unchanged in appearance.

Since all the specimens are precisely of the same dimensions the results indicate that the losses of steel from corrosion in water, whether in contact or alone, were nearly proportional to the surface exposed, and apparently without galvanic or contact action proving a factor in the amount of deterioration. It must be remembered that water had free access to one side only of the metals that were in contact and this explains why the steel plate not in contact with other metals seemingly lost twice as much from corrosion as the plates that were in metallic contact.

### DEDUCTIONS FROM RESULTS

The evidence from these experiments apparently indicates, however, that contact between steel and bronze, and steel and the other metals of the series, neither promotes nor accelerates the corrosion that normally takes place in steel alone. From the standpoint of chemical equilibrium steel is, in the presence of water and oxygen or any electrolytic solution, an unstable system. In an unhomogeneous material of this character galvanic activity is induced at various points on its surface, i.e., localized action between the steel and its impurities. Every particle of surface impurity, whether consisting of carbon, cinder, or oxide, forms with iron a galvanic couple, or minute battery. By its very lack of homogeneity in composition and structure the average steel surface in water as it occurs in nature presents all the conditions necessary for active electro-chemical corrosion.

What the writer once termed auto-electrolysis is the inevitable outcome, and this process in steel does not appear to be hastened by contact with other metals or alloys. In fact, the legitimate conclusion from the foregoing experiments is that rather less than more galvanic action arises from contact between steel and the other metals of the series than from contact between steel and steel. In actual practice it has been found that if a steel nut is put on a steel bolt and subjected to corrosive conditions, in a comparatively short time the steel nut will have to be hammered or split off, if gotten off at all, on account of rusting together from local corrosive action; whereas a brass or bronze nut on a steel bolt under similar condition can be readily screwed off. This is a very important consideration where quick changes in water works machinery or installation must of necessity be made from time to time.

### RESULTS OF PRACTICAL EXPERIENCE

H. J. Force, of Scranton, Pa., engineer of tests of the Delaware, Lackawanna & Western Railroad, recently told the writer that in the coal department of his company considerable bronze was used as bushings, valves and impeller blades, in connection with cast iron in pumping machinery for mine waters. The cast iron having suffered from corrosion under these conditions, the engineers thought the trouble was due to galvanic action from the contact of two different metals in the acid mine water. This led to the elimination of the bronze bushings with the replacement of cast iron, so that the parts in contact would be of the same metal. It was soon observed, however, that the cast iron here lost even more rapidly than where in contact with bronze. The bronze bushings in the mine pumps were, therefore, reinstalled. Mr. Force stated that throughout their experience in dealing with mine waters cast iron in contact with bronze lasted longer and withstood corrosive action better than cast iron in contact with cast iron.

According to the English authority, J. Newman ("Corrosion of Metallic Structures," page 185), experience has shown that where brass bolts have been used to fasten the planking or wooden sheathing of ships to the steel or iron plates of the vessel, no deterioration has resulted, whereas iron bolts in the same situation have soon become corroded. This evidence concerning the behavior of cast iron and steel in contact with brass or bronze in mine water and sea water only corroborates our own deductions from the results of experiments with steel in fresh water. Hence we arrive at the conclusion that for steel or iron machinery that is to be under water it is better engineering practice to put a bronze nut on a steel bolt and brass fittings on such machinery than steel on steel, or iron on iron, in the same situation.

It has long been recognized that the nonferrous metals are less corrodible than iron or steel. As a provision against galvanic action, where the item of expense is not to be considered, or where the conditions are severely corrosive, it is always preferable to employ one of these metals alone, and every care should be taken to insure that it is homogeneous and of the same composition.

Where two different metals must be used together under water, owing to the certainty of some galvanic action, it goes without saying that the connections or points of attachment should be covered or protected as far as possible from absolute metallic contact.

### USE OF BRONZE

Mr. Thomas J. Gannon, mechanical engineer and inspector in charge of the outside work of the Department of Water Supply, Gas and Electricity of New York City, told the writer that he had seen steel rods that were sleeved with bronze and apparently no galvanic action occurred even in salt water. Mr. Gannon stated that on gland bolts on high-pressure valves the department has used bronze nuts on steel or wrought-iron bolts. In some cases this installation has been in existence four or five years and no indication of any deterioration has been observed. In these cases manganese bronze nuts were used. At the present time the New York Department of Water Supply is using a combination of steel or wrought-iron bolts with bronze nuts for holding down stuffing box glands. Where wet and dry conditions alternate or where quick action is required for repairs and changes, Mr. Gannon said that as much bronze should be used as possible.

R. W. Steed, mechanical engineer, stated that it is the common practice of the Department of Water Supply to use bronze or brass nuts on steel bolts. The advantage is that the nut can be easily removed. Mr. Steed said he had never heard of any trouble from galvanic action in such practice. Where brass nuts are put on steel bolts, if there is any trouble at all, it is far less than that which would be experienced with a steel nut on a steel bolt, on account of the latter rusting together. Mr. Steed said that in marine practice it is very common to use bronze nuts on steel bolts. In the assembling of the propeller, the blades are frequently secured to the hub of the propeller by means of steel studs with brass caps, and these parts are in water. If the item of expense is not considered both bolt and nut could be of bronze or Monel metal, which no doubt would be superior, but in present practice steel bolts with brass or bronze nuts are most commonly used.

# Compensation of Engineers

Report by Special Committee of the American Society of Civil Engineers

IN January, 1913, the Board of Direction of the American Society of Civil Engineers designated Mr. Alfred Noble, Mr. John A. Bensel, Mr. S. L. F. Deyo, Mr. C. F. Loweth and Mr. George W. Tillson as a special committee to investigate the conditions of employment and compensation of civil engineers throughout the country; to collect statistics and data in reference thereto and to report the results of such investigations to the society. The substance of the report, which was presented at the society's annual meeting, Jan. 21, follows.

### INFORMATION SOUGHT

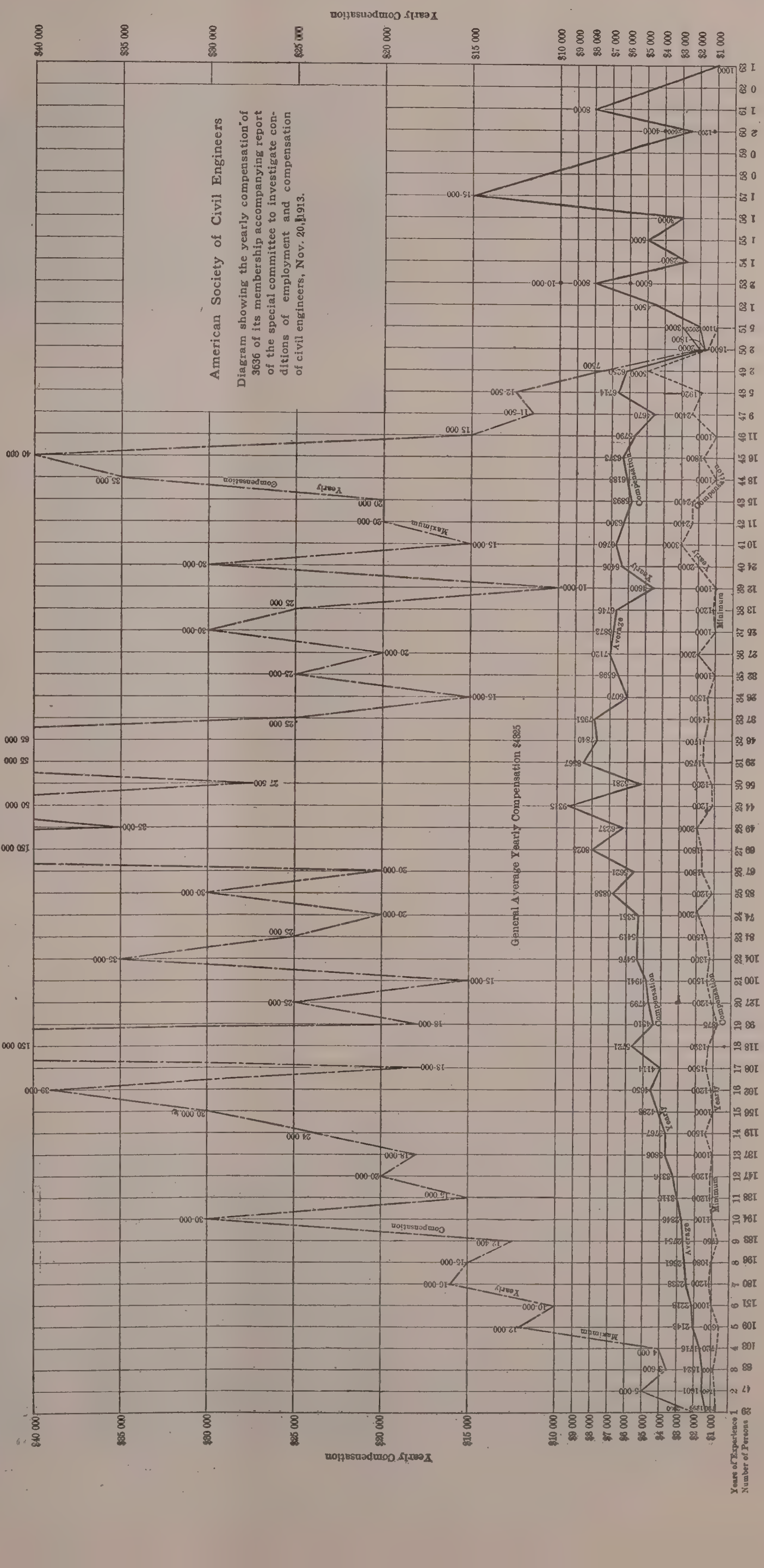
In April a circular was mailed to the entire membership of the society asking each to fill out a form stating specifically (1) his residence, (2) his age, (3) whether or not he is a technical graduate; (4) if a graduate, the year of graduation and the degree conferred; (5) the number of years he had been in active practice, and the character of such practice, whether civil, mechanical, electrical, etc.; (6) the number of years he had been in responsible charge of work; (7) his present title, omitting names of corporations, municipalities, etc.; and (8) his yearly rate of compensation, whether from a salary or from income from private practice, or from both. He was asked to give in a somewhat more extended way the general character and extent of his professional work, and to make any other comments on personal or local conditions and as to the reasons governing the same.

This circular was mailed to 6850 persons, and in it the committee stated its belief that the membership of the society was large enough to be representative and to be typical of the various stages of engineering life. It was stipulated that the information given would be regarded by the committee as strictly confidential, members not being asked to sign their statements, and that the replies when they had served their purpose would be destroyed.

### FORM OF RECORD

To carry out this agreement, a number was placed indiscriminately opposite the name of each member on a mailing list. When all were mailed this list was sealed. Records of the numbers on the envelope of each reply received were kept so that later a new unnumbered list could be made, showing simply by check marks the names of those who did not answer. This was done and the original list destroyed.

There is a great deal of information on the original replies, which the committee hopes to use in preparing a later report, but as



American Society of Civil Engineers

Diagram showing the yearly compensation of 3636 of its membership accompanying report of the special committee to investigate conditions of employment and compensation of civil engineers, Nov. 20, 1913.

soon as they have served this purpose they will also be destroyed.

About 3900 replies were received, and of these 3636 were filled out in such a manner as to be available for the work of the committee.

A diagram is presented herewith covering these 3636 replies in the following manner: Those who have been in active practice one year are grouped, then those who have been in active practice for two years, and so on. For each of these groups the minimum, maximum and average yearly compensations are plotted, and the points connected to form curves. The average curve errs, if anything, in being slightly too low, because in a number of cases the salary is given, and it is stated that in addition the member receives expenses, house rent, share of profit of firm, sustenance, etc., and the salary figure has been used.

### WHAT THE DIAGRAM SHOWS

In a general way the diagram shows that starting with the first-year group, the average remuneration is $1300, and that a surprisingly uniform increase is developed. At the end of five years the average rate of compensation is $2000; at the eleventh year, $3000; at the fifteenth year, $4000; at the twenty-first year, $5000; at about the twenty-fifth year, more than $6000; reaching the highest general average of about $7500 between the twenty-seventh and thirty-third years of practice. After that period the average rate of compensation gradually decreases, remaining, however, above $6000 up to the forty-fifth year. From that point the curve is very irregular, and after the forty-seventh year is practically of no value as an average on account of the small number of replies received. This small number is not surprising, however, inasmuch as these practitioners must be at least seventy years old.

It will be noted that in each group there is always one individual whose rate of compensation is far below the average, but that in all the groups up to forty years of active practice the yearly minimum rate is always below $2000, except in four instances, when it just reaches that figure. The maximum rate of compensation for each group naturally varies greatly, but attention is called to the fact that in two cases it reaches $150,000 for purely professional remuneration. The general average compensation for the 3636 members is $4325. It is an interesting fact also that for the first fifteen years the average yearly compensation of the 1972 who replied is $2827.

### CURVE OF MIDDLE MEN

An attempt was made to present the matter from a slightly different point of view, by drawing a curve representing the compensation received by the middle man of each group, that is the compensation exceeding, and exceeded by, that of an equal number of men; but while it may be stated that the compensation of this middle man is, in most of the groups, less than the average for that group, such irregularities appeared that the committee withholds the results for further study.

Of the total 3636, just 25 per cent are not graduates of technical schools. It is to be regretted that all the membership of the society did not reply to the inquiries of the committee, as that would have added weight to the averages given in the report.

A more complete report will be issued in the near future.

Side View of Apparatus for Combustion of Coal

## Improvised Mine Fires on an Experimental Scale

Underground Fire Chamber for Experiments on Spontaneous Combustion and Mine Fires

THE U. S. Bureau of Mines has recently installed at its Pittsburgh experiment station an underground chamber or furnace in which to carry on experiments relating to mine fires and spontaneous combustion as occurring in mines. A section of a cylindrical steel tube 6½ ft. in diameter and 27 ft. long was laid on its side in a deep trench, and after lining this shell with firebrick and mineral wool and stopping the ends with 13-in. brick walls it was covered with 2 ft. of earth. The chamber was constructed so as to be as nearly airtight as possible, and in such manner as to retain to the greatest degree practicable any heat generated within its walls.

At one end a motor-driven fan will blow in air at a rate which can be accurately measured and at the other a stack is provided which can be opened or closed as desired. Through the top of the chamber pass, at frequent intervals, small pipes for withdrawing samples of air or gases and for inserting pyrometers for temperature measurement in the interior.

The chamber when one-third full will hold 6 to 8 tons of coal. It is expected that different kinds of coal or of the gob or waste material from mines will be placed in the chamber and a study made of spontaneous development of heat in them under various conditions. After an active fire has been started in the chamber either by this means or artificially, experiments will be made on controlling the fire by reducing the air supply or by sealing it off entirely. In an endeavor to apply the data to solving practical problems in the treatment of mine fires the progressive changes in composition of the fire gases or of the air surrounding the coal will be followed and temperature measurements made.

Investigations have been made in other countries, and to some extent also in this country, of the gases produced in actual cases of mine fires both before and after sealing off a burning area. The bureau is now making probably the first attempt to investigate such problems in an experimental apparatus which permits careful control of conditions and yet is on a scale nearly commensurate with mining operations.

The investigations are being carried on by Mr. Horace C. Porter, chemist, of the Bureau of Mines.

## Foreign Bridge Construction

AMONG the most important foreign bridges now under construction or completed last year there were recently enumerated in the "Engineer" the Sara railroad bridge over the Lower Ganges, comprising fifteen 359-ft. spans, with foundations carried down to a depth of about 162 ft. below water level. It is being built at an estimated cost of more than $6,000,000. The Allahabad railroad bridge in India is 1¼ miles long and has forty 150-ft. spans. The Potergy River bridge in Brazil has ten 164-ft. spans. A viaduct on the railroad from Miramas to L'Estaque in the south of France is 3093 ft. long.

Gas and Air Connections to Chamber

Brick Lining in Combustion Chamber

## The Hand-Hammer Drill — Its Advantages and Limitations

**Comparison of Mounted and Unmounted Types of Drill Favors Lighter Machine for Specific Kinds of Work**

On such work as shaft-sinking, drilling rock ledges in roadbuilding, trimming tunnels, quarrying, digging trenches and tearing up pavements the unmounted hand-hammer type of drill, according to the experience of the Ingersoll-Rand Company, possesses certain marked advantages over the mounted drill, although the lighter machine has its limitations, principal among which is the depth of hole that may be drilled economically. In extremely hard rock the range for the hand drill has been as low as 5 or 6 ft.; in medium ground, 12 ft., and in favorable ground, 20 ft. The company's estimate of the usefulness of the lighter hand hammer drill is summarized below:

The hand-hammer drill is essentially a one-man machine, its weight being 20 to 50 lb.; it may be used in restricted quarters and more drills may be employed per unit of space, due to the absence of mounting and the elimination of helpers. The adoption of such unmounted drills, it is claimed, has been accomplished without any sacrifice of speed; on the contrary, they have proved a material aid in securing results greater than could be obtained with other types, and this is leaving out of consideration certain other advantages inherent in the hand type. It must be kept in mind, however, that the hand-hammer type is adapted only to certain kinds of work.

### DRILLING TIME

The time factor in drilling may be considered as made up of the following elements: Setting up the drill; drilling the hole; shifting position, and removal. With the hand drill there is no time consumed in setting up, as the drill is unmounted. With the types of mounted drills in which the steel reciprocates with the piston it is necessary to employ steels of large diameter with correspondingly large bits, owing to the heavy crushing nature of every blow and the severe shocks to which the steel is subjected. Moreover, a certain amount of power is consumed in the rubbing of the bit against the walls of the hole, which results in very rapid wear of the bit unless sufficient metal is provided.

In the hammer drill the steel is not reciprocated with the piston, but rests loosely in the chuck and is struck a great many light blows by a rapidly moving piston, the bit end of the steel being at all times against the rock. The lateral movement of the steel is very slight—the rebound only—as compared to the reciprocation of several inches with the mounted drill. With the hand type the great reduction of rubbing of the bit against the walls of the hole reduces the wear on the wings of the bit, so that bits of smaller gage variations may be employed. In other words, to obtain a hole of a given size at the bottom a smaller size of starter bit may be employed than would be advisable with the mounted type of drill. In the one type the steel is rigidly clamped to the piston rod; in the other it rests loosely in the chuck and is prevented from going too far into the cylinder by a collar on the shank of a steel or by means of an anvil block interposed between the end of the steel and the piston. The latter constructions mean less time consumed while changing steels and in removing steels so as to clean the hole.

### AUTOMATIC ROTATION

The time required for removing the steel from the hole is still further reduced when a steel holder is employed, especially if it is of a type that can be slipped into place quickly. In the mounted type the steel is invariably automatically rotated. In the hand type there are two methods of rotation—by hand and automatically. A drill embodying automatic rotation will produce a uniform hole and will relieve the operator of the most irksome part of his work.

The time required for mounting and for the various operations of shifting mounted types of drills is often greater than the actual time of cutting, whereas with the hand-hammer drill this element is practically eliminated, for it requires but a few seconds to shift.

Trimming Tunnel with Hand Drill

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## Fuel Oil for Steamships

The use of fuel oil for steamships has been constantly on the increase on the Pacific Coast, according to a recent Canadian Government report, largely because it is considered that 2 tons of oil will do the work of 3 tons of the best coal. The advantages in favor of oil are counted as having five main points: Great saving of time and labor in loading fuel; fewer men required for handling fuel on board ship; reduced cost of boiler and other repairs; increased cleanliness; and more complete combustion, and therefore greater efficiency of oil fuel. Recently many vessels have been altered so as to use either coal or oil fuel. Comparative costs of coal and oil on the "Princess Victoria," operating daily between Vancouver, Victoria and Seattle, are given as follows:

| COAL | Per day |
|---|---|
| 100 tons at $4.50 | $450.00 |
| 9 firemen at $55 per month each | 16.50 |
| 9 trimmers at $45 a month each | 13.50 |
| Food for 18 men | 7.50 |
| Total | $487.56 |
| OIL | |
| 344.17 bbl. at 90 cents | $314.25 |
| 6 firemen | 11.10 |
| Food for six men | 2.53 |
| Total | $327.87 |

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## Iron Ore Breaks Record

**Production of 1913 Exceeds by Large Tonnage the Record Figures in 1910**

The quantity of iron ore mined in the United States in 1913 is estimated by E. F. Burchard, of the U. S. Geological Survey, to have been between 58,000,000 and 60,000,000 long tons. This estimate is based on preliminary reports from 25 of the largest iron-mining companies, which represent the principal iron-producing districts and whose combined output is about 81 per cent of the total iron ore mined in 1912.

The average increase in output shown by these 25 companies was 8 per cent over that for 1912, and if this increase should be maintained by all the iron companies in the United States the total output of iron ore for 1913 should reach 59,500,000 long tons. At any rate, it appears almost certain that the former high record of iron ore mined, 57,014,096 long tons in 1910, has been surpassed in 1913.

In the Lake Superior district, where about 85 per cent of the domestic iron ore is mined, the increase in production corresponded closely with that for the United States in general, or about 8 per cent, thus indicating a total production for that district of about 50,000,000 long tons, compared with 46,368,878 tons in 1912. The year 1913 is therefore a record year for production and shipments in this district also.

The preliminary figures indicate that the shipments of Lake Superior ore by water will exceed 49,000,000 long tons, which, together with the all-rail shipments of more than 800,000 tons, brings the figures for total shipments of Lake ore very close to the tonnage of ore mined and indicates that not much change has occurred in the stocks of ore at the mines in the Lake district. These stocks amounted at the close of 1912 to about 9,500,000 long tons of ore.

In the Birmingham district, Alabama, the production of iron ore in 1913 as indicated by the preliminary returns was about 10 per cent greater than that for 1912. In Tennessee there was apparently a slight decrease and in North Carolina a slight increase. New Jersey and New York both showed slight increases, while Pennsylvania showed a slight decrease. In the Rocky Mountain district of Wyoming, Colorado and New Mexico there was a slight decrease.

The types of iron ore produced commercially consist of red and specular hematite, brown ore, magnetite, and siderite, or spathic ore. Hematite constitutes about 90 per cent of the output. Only a very small fraction of 1 per cent of the output is siderite, the production of brown ore and magnetite together constituting nearly 10 per cent of the total.

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OIL AND COAL FUEL IN A SHAY LOCOMOTIVE were compared as to cost in a paper read by Mr. H. W. Sessoms, of the Ebey Logging Company, before the recent logging congress in Spokane, Wash. The locomotive weighed 60 tons and made two trips of 40 miles each per day. It regularly made five trips on 15 tons of coal, costing $63.75, while after being equipped for oil the five trips over the same track and with the same loading consumed 45 bbl. of oil, costing $49.50, or a saving of a little more than 7 cents per mile in favor of the oil.

# Bituminous Materials for Roads

### Abstract of Report of Special Committee Submitted at Annual Meeting of American Society of Civil Engineers

IN its report submitted this week at the meeting of the American Society of Civil Engineers the Special Committee on Bituminous Materials for Road Construction and Standards for Their Test and Use deplores the tendency to devote time and energy to the discovery of "the most satisfactory road surface," and expresses the conviction that there is no panacea for all highway ills. One of the greatest problems to be solved by highway engineers, in the estimation of the committee, is the proper selection of the particular material and form of construction to meet most efficiently the conditions of any particular case. Continuing, the committee gives conclusions which are abstracted below. A proposed nomenclature of 102 terms is included in the report.

*Census of Traffic.*—Experience has demonstrated the value of a traffic census taken both preliminary and subsequent to the construction of a highway. The traffic census should be considered one of the most important variable factors in the solution of that important problem—the selection of that type of construction best suited to local conditions considered from the standpoints of both economy and efficiency. In connection with the census returns on any highway should be considered the traffic on cross and parallel highways and the effect of improvement of these highways on the traffic of the highway under consideration.

Where motor traffic forms a considerable proportion of the total traffic likely to use a highway, the unit width of traffic lines should be considered as 9 or 10 ft., instead of 7 or 8 ft, as heretofore, because of the greater clearance required for the safe passing of the units of such traffic. In view of the recent constant and rapid increase of traffic on the highways, it will in the interests of economy for designs of highways to be made with proper consideration of further increases.

*Collection and Standardization of Cost Data.*—It seems urgent that standards for arriving at costs be established and generally adopted as promptly as possible.

## GENERAL CONSTRUCTION

The use of any form of a bituminous pavement or surface does not preclude the necessity for the construction of a well-drained, thoroughly compacted and adequate subgrade. In fact, such improvement of the highway frequently attracts heavier traffic and thus increases the stresses in the subgrade.

Within certain limits of traffic the proper use of bituminous material should effect economy in the expenditures for cleaning and maintenance. The proper treatment of a broken stone, gravel, shell, or slag road with bituminous material for the purpose of eliminating the so-called dust nuisance will at the same time render even the best of such roads more efficient for sustaining traffic, and such treatment with bituminous materials is usually preferable to and more economical than sprinkling with water, or the use of hygroscopic salts. An objectionable slipperiness of bituminous pavements or surfaces may be decreased or prevented by proper precautions during construction or by proper treatment later.

The crown generally used in the construction of broken stone roads is excessive when bituminous materials are used, and a crown of even ½ in. per foot should be avoided when a lesser crown can be secured without detriment to the surface drainage.

*Materials.*—Where bituminous pavements are laid, the edges should be protected and a sudden transition from the pavement to any softer shoulder material avoided by means of cement concrete or other edgings and such reinforcement of the shoulder material as may be necessary.

The character of the stone to be used may influence the choice of the bituminous material. Whatever method may be used in any case, it is essential as in water-bound construction that a suitable quality of road metal be used. By proper selection and use of the bituminous material, injury to property and deleterious effects upon animal and vegetable life may be avoided, and also considerable hygienic advantage may result from the use of such material on the highways.

The maximum amount of distillate up to 170 deg. C. allowable in tars may depend upon the proportions of the other fractions in a tar, the conditions of use of the tar, the conditions on the road surface after its construction, or possibly other factors.

## DETAIL METHODS

Selection of the method of construction to be used in a given case will depend upon the results of preliminary investigations, and the recent and imminent development of mechanical appliances will affect the decision to a great degree. Whatever method is selected, the use of a bituminous material by no means justifies any lack of care in the ordinary details to be followed, but rather increases the need for thoroughness and skilled supervision.

The main principles underlying perfection in water-bound roads remain in full force when such roads are treated with bituminous material. In all uses of bituminous materials in highway work, the use of proper machinery is preferable, wherever conditions make such practicable in any part of the process, to the use of hand labor.

The use or omission of a seal coat on bituminous pavements is dependent upon one or more of the following points:

(a) The character of the bituminous material used. (b) The method of construction. (c) The density and quality of the work done, and (d) the kind and amount of traffic to be expected on the completed highway.

*Mixing Methods.*—Where the character of the traffic justifies the use of a bituminous concrete pavement, the same conditions demand an extraordinarily strong foundation therefor. The amount of bituminous material to be used in any case will depend upon the peculiar conditions of that case, such as the kind of road metal and of bituminous material, the character of the aggregate, the climatic conditions, etc. The character of the mineral aggregate to be used may be controlled by local conditions, but the best results can only be obtained by the use of the best materials. Excessive sizes or variations in size of the mineral particles should be avoided, and the utmost care must be taken to avoid the segregation of the different size particles.

Mixing machines should be used, and hand-mixing methods avoided wherever practicable. The success of results is greatly dependent on the degree of uniformity obtained in spreading the mixture and upon the proper rolling and compacting of the mixture. Too heavy a roller should not be used.

Care should be taken in prescribing or laying any seal coat that invitation or excuse is not given for inferior prior work and its concealment by such a seal coat. Fine sand on top of bituminous concrete is open to grave objections, and clean stone chips or small gravel free from particles that will pass through a ⅛ in. mesh seem preferable.

Trap rock in sizes greater than that passing a 2 in. screen should be used with caution in the construction of the upper course unless the voids of the same are properly reduced, because of the liability of the individual stones to rock under traffic. In the use of a heated aggregate for the construction of a bituminous concrete pavement non-uniformity or excess in the heating of stone should be avoided.

## SURFACE TREATMENTS

The success of surface applications is proportionate to the adhesion by the bituminous material to the old road surface, and such degree of cleanliness of the latter must be had, by means of sweeping or other methods, as will insure a proper degree of adhesion.

Whether or not the application of bituminous material is to be followed by an application of mineral material, and the amount of time to be allowed to elapse between the application of bituminous material and a subsequent application of mineral material, depends upon local conditions and upon the character and amount of the bituminous material used.

Attempts to construct and maintain by bituminous surface treatments a carpet of a greater total thickness than ½ in. have generally been unsuccessful, and in the construction of a successful carpet of a total thickness approximating ½ in. the materials should be applied in layers, at intervals, rather than by the construction of the total thickness in one application.

The amount of bituminous material to be used depends upon the local conditions in any particular case, but excess in any application is to be avoided, as a deficiency may be corrected by a subsequent application, whereas an excess in any application is difficult, if not impossible, of the aforementioned correction.

The application of the bituminous material by means of a pressure distributor is, wherever practicable, preferable to gravity or hand-pouring methods.

The maximum amount of residue allowable in an asphaltic oil used for superficial treatment should be as great as permitted by the physical conditions of its use subject to certain limits in the penetration of this residue, and such limits in penetration should be a minimum which will insure against undesirable hardness or slipperiness under travel at low temperatures, and a maximum which will insure against undesirable softness or lack of body at the highest temperatures to be expected after use on the road.

# Proposed Refuse-Disposal Plant at Trenton

## Hering & Gregory Recommend 120-Ton Incinerator, which Will Supply Steam for Driving Sewage Pumps and Clinker for Concrete

A COMPARISON of reduction and incineration in their relations to the future sewage disposal needs of Trenton, N. J., was made in the report submitted by Hering & Gregory, consulting engineers, of New York, who were retained on Aug. 1, 1913, to make a sanitary survey of the city. Using this comparison as a basis, the engineers advise that all garbage and rubbish, with at least 20 per cent of ashes, be burned in a new high-temperature incinerator having a capacity of 120 tons per day, that a power plant be built to transmit electric current generated by the heat of the incinerator to a pumping station at the proposed sewage disposal works, and that a clinker mill be built to prepare the clinker from the incinerator for use in concrete foundations under street pavements. The portion of the ashes not needed to produce a good clinker will, as at present, be carried to dumps or used in filling low lands. Ashes are to be collected separately from garbage and rubbish.

### ADMINISTRATION OF PRESENT METHODS

The report indicates that the present methods of disposal, though not suitable for a large growing city, are being well administered. Since April 1, 1913, a law has required that garbage be drained and wrapped in paper for collection with rubbish; these are burned in a Davis crematory, which, incidentally, is not adapted to the production of steam and the generation of power. During the year ended Feb. 28, 1913, 13,849 tons were burned in the furnace, the daily maximum being 62 tons. The labor force included 4 men besides a superintendent and clerk; 275 tons of coal were burned at the plant. The total cost for the year was $6634, or $0.48 per ton, not including deterioration or fixed charges. The maximum monthly average of garbage and rubbish collection was 1604 tons in September, and the total per capita weight was 270 lb. per year.

The amount of ashes collected during the same period was 38,285 tons; the maximum monthly collection was 5105 tons. The cost of collecting and dumping was about $0.35 per ton, not including fixed charges on plant and equipment. This low charge is due to the fact that land for dumping purposes is supplied free, as well as that the street grades in Trenton are low and the average haul to the dumping ground is short. The total yearly per capita weight of the ashes is 730 lb.; the combined per capita weight of garbage, rubbish and ashes is accordingly 1000 lb.

### ASSUMPTIONS IN ESTIMATING FUTURE NEEDS

The present population of Trenton is taken at 110,000, working from the figure of 96,815 allotted by the census of 1910; the engineers assume that in 1930 the population would be 150,000. Using 1000 lb. per capita as the yearly collection this population would supply 13,500 tons of garbage, 6750 tons of rubbish and 54,750 tons of ashes per year. By using the maximum figures for 1912 a maximum weight of mixed refuse per day of 123 tons was indicated. Table 1, giving the comparative costs of construction of plants for disposal respectively by reduction and by incineration, indicates one reason why the engineers advised the selection of the latter method.

The detailed estimates of relative operating costs are given in Tables 2 and 3.

TABLE 2—ESTIMATED NET ANNUAL OPERATING COST FOR INCINERATION PLANT

| | | | |
|---|---|---|---|
| INCINERATOR | | | |
| *Operation—* | | | |
| Supervision and labor | $13,680 | | |
| Removal of ashes | 600 | | |
| Maintenance and repairs. | 1,700 | | |
| Crushing and screening clinker | 2,000 | $17,980 | |
| *Income from Sale of Product—* | | | |
| Clinker | ..... | 5,000 | |
| | | $12,980 | |
| *Fixed Charges—* | | | |
| Interest, 4.500 per cent on $195,500 | $8,800 | | |
| Sinking fund, 3.356 per cent on $195,500 | 6,560 | 15,360 | |
| Total estimated net annual cost of operation of refuse incinerator | ..... | $28,340 | $28,340 |
| SEWAGE PUMPING | | | |
| *Operation—* | | | |
| Labor in power plant at incinerator | $2,520 | | |
| Labor in sewage pumping station | 3,720 | | |
| Coal for Sunday operation | 1,140 | | |
| Oil, waste, packing and miscellaneous supplies. | 750 | $8,130 | |
| *Fixed Charges—* | | | |
| Interest, 4.500 per cent on $172,500 | $7,760 | | |
| Sinking fund, 1.783 per cent on $172,500 | 3,080 | 10,840 | |
| Total estimated annual cost of operation of sewage pumping station | ..... | $18,970 | 18,970 |
| Total estimated net annual cost of operation of refuse incinerator and sewage pumping station | | | $47,310 |

Another point of advantage brought out by Hering & Gregory is that the city will have at all times its own market for the power generated and the clinker produced at the incinerator, whereas if reduction be chosen the city must find a market for the sale of grease and tankage produced at the works and must enter the field of competition with privately owned and operated works which produce those materials.

As the maximum daily quantity of mixed refuse has been estimated as about 123 tons, it is seen that two 60-ton high-temperature furnaces will be ample. Three 200-hp boilers are included in the estimate—one for each incinerator and the third as a reserve. In estimating the amount of power which could be obtained from the incineration of the refuse an evaporation of 1 lb. of water per pound of refuse has been assumed. The power which could be developed at the incinerator when running at rated capacity, after deducting station losses and power required to operate the incinerator, would be about 350 kw. The power required to be delivered to the transmission line for pumping sewage would be only about 275 kw.

TABLE 1—ESTIMATED CONSTRUCTION AND OPERATION COSTS FOR REFUSE DISPOSAL BY INCINERATION AND BY REDUCTION

| Method | Cost of construction | | | Annual cost of operation | | |
|---|---|---|---|---|---|---|
| | For disposal of refuse | For pumping sewage | Total | For disposal of refuse | For pumping sewage | Total |
| Incineration | $195,500 | $172,500 | $368,000 | $28,340 | $18,970 | $47,310 |
| Reduction | 241,500 | 174,800 | 416,300 | 44,780 | 28,360 | 73,140 |
| Saving in favor of incineration | 46,000 | 2,300 | 48,300 | 16,440 | 9,390 | 25,830 |

### CLINKER IN PAVEMENT FOUNDATIONS

The assumed yearly total of mixed refuse burned in 1930 with a population of 150,000 is 25,300 tons. Assuming further that the residuum from the furnaces would be 15 per cent of this weight, of which 80 per cent would be clinker suitable for concrete, the total quantity of clinker per year would amount to 3000 tons, or, using a unit weight of 1200 lb., 5000 cu. yd., a quantity less than the amount of broken stone now used in street paving. Having suggested this market for the clinker, the engineers allowed a return for the sale at the rate of $1 per cu. yd. The broken stone at present used for this work in Trenton averages about $1.53 per ton on board cars at Trenton, and about $1.83 per cu. yd. The report calls attention to the success of this plan in many cities of Europe, especially in England. In Liverpool six refuse incinerators generate electric power to operate tramways, and the clinker is used in paving.

TABLE 3—ESTIMATED NET ANNUAL OPERATING COST FOR REDUCTION PLANT

| | | | |
|---|---|---|---|
| GARBAGE REDUCTION | | | |
| *Additional Cost of Separate Collection of Garbage and Rubbish—* | | | |
| Cost of separate collection | $65,140 | | |
| Cost of combined collection | 49,950 | $15,190 | |
| *Transporting Garbage from Loading Station to Reduction Works—* | | | |
| Labor at loading station | $800 | | |
| Labor operating motor trucks | 3,360 | | |
| Supplies for and maintenance of motor trucks. | 6,030 | 10,190 | |
| *Garbage Reduction Works—* | | | |
| Supervision and labor | $18,960 | | |
| Coal | 12,750 | | |
| Naphtha | 1,100 | | |
| Supplies and miscellaneous expenses | 2,500 | | |
| Repairs and renewals | 1,500 | 36,810 | |
| | | $62,190 | |
| *Income from Sale of Product—* | | | |
| Grease | $28,350 | | |
| Tankage | 10,400 | 38,750 | |
| | | $23,440 | |
| *Fixed Charges—* | | | |
| Interest, 4.500 per cent on $241,500 | $10,870 | | |
| Sinking fund, 3.356 per cent on $241,500 | 8,100 | 18,970 | |
| Total estimated net annual cost of operation of reduction works | ..... | $42,410 | $42,410 |
| RUBBISH INCINERATOR | | | |
| *Operation—* | | | |
| Labor | $1,395 | | |
| Supplies and miscellaneous expenses | 170 | | |
| Repairs and renewals | 400 | | |
| Removal of ashes | 405 | | |
| Total estimated annual cost of operation of rubbish incinerator | $2,370 | ...... | 2,370 |
| SEWAGE PUMPING | | | |
| *Operation—* | | | |
| Labor in power plant at reduction works | $5,760 | | |
| Labor in sewage pumping station | 3,720 | | |
| Coal | 7,140 | | |
| Oil, waste, packing, and miscellaneous supplies. | 750 | $17,370 | |
| *Fixed Charges—* | | | |
| Interest, 4.500 per cent on $174,800 | $7,870 | | |
| Sinking fund, 1.783 per cent on $174,800 | 3,120 | 10,990 | |
| Total estimated annual cost of operation of sewage pumping station | ..... | $28,360 | 28,360 |
| Total estimated net annual cost of operation of reduction works, rubbish incinerator and sewage pumping station | | | $73,140 |

# Purchasing City Supplies

## Fourth and Concluding Portion of Report by Elihu C. Church on Inspection and Storage System of Bureau of Supplies, Department of Water Supply, New York

IN three former articles (see Engineering Record of Jan. 3, page 21; Jan. 10, page 52, and Jan. 17, page 81) the reorganization of the Bureau of Supplies of the Department of Water Supply, Gas and Electricity of New York City, as set forth in a report of Elihu C. Church to Commissioner Henry M. Thompson, was discussed. This, the concluding article of the series, deals with the inspection and storage of municipal supplies.

### INSPECTING SUPPLIES

The purpose of inspection is to make sure that the quantity and quality of goods delivered correspond with what was called for. In the days before there was a storekeeping system and when practically all supplies were delivered direct to the men who were going to use them, these men themselves, in many instances, made whatever inspection was attempted. Strange to say, it was hard to overcome this way of doing things, for some argued that no one knew better what he wanted than the man who ordered the goods, therefore no one was better fitted to inspect them. Needless to say, "what the man wanted" is not the criterion to use in passing on supplies. The point to be settled is whether or not the department is getting exactly what was described by the specifications.

In order that the same standards might prevail everywhere throughout the department, the only employees now allowed to pass on goods are the trained storekeepers who inspect all supplies delivered at storerooms, and the inspectors who travel around and check up the direct deliveries. The standardization of specifications has made all this work much simpler and easier.

Long and uncertain periods used to elapse between the delivery of goods and a report of their inspection reaching the auditor. Since no goods can be paid for till they have been accepted, and quick payment of bills is one of the ideals now being striven for, every effort is made to expedite the work of inspection in order to attract bidders and stimulate competition. A procedure has been developed for doing this work systematically and with the least likelihood of error or delay.

### DISPOSAL OF SUPPLIES

Storekeepers place all incoming goods in an "inspection cage" where they remain till unpacked and checked for size, quantity and quality. If the determination of quality requires an analysis, a sample is sent to the laboratory. Satisfactory material is at once put into stock and rejected material is packed up for return shipment and put in a separate room by itself—and a report sent to the central office. All this is generally done the same day the goods are received. The new policy of having practically all goods delivered at store houses has simplified and expedited the inspection problem to a remarkable degree. However, there are times when it is best to deliver supplies direct to the point where they are to be used (lumber, cement, etc). All such delivery points are supplied with addressed postals on which the men receiving goods are directed immediately to notify the central office of their arrival.

These cards are sorted by a clerk who checks off the deliveries on the record of purchases. The cards are then turned over to the inspectors to show them what points to go to. Formerly there was no system in making inspections, inspectors going hither and thither, in a most obliging but inefficient way. Now certain territories are covered on certain specified days.

### STORAGE AND ISSUE

Since the price of many articles fluctuates greatly during the course of a year, it should be a purchasing policy to "stock up" at the time when goods may be bought most cheaply. A storeroom in which such supplies are kept till wanted may be likened to a storage reservoir in a watershed where the abundance of the spring rains are collected and held till the period of summer drought.

Furthermore, up to a certain point, lower prices are obtained by the purchase of large quantities at one time; but the limit of wholesale buying is fixed by the fact that keeping stock involves loss through interest on money tied up in unproductive materials; insurance and taxes; deterioration; cost of excess storage space; cost of supervision. These conditions therefore determine the maximum quantities of current supplies which can be profitably stored.

On the other hand, it takes time to obtain or replenish stock by purchase, so sufficient supplies for current consumption must be carried in order to tide over the interval required to get more. It is much cheaper for a dealer or manufacturer to ship a large consignment to a single conveniently located storeroom. It is now conceded to be a grave error in organization to place the control of materials and supplies in the hands of the men who are to use them. The storage and issue of supplies have therefore been put upon an entirely new basis during the past two years.

In the old storerooms the bins had vertical fronts and were too high. The new type of bin has a front which slopes backward from the bottom. This form of construction gives better light to the interior of the bins, makes them more accessible, and allows more alley space.

A card is made out for every class and size of stock. These store cards, besides describing the articles, give their location in the storeroom, their unit price, and the dates and amounts of all receipts and issues. They thus constitute a perpetual inventory and show at all times the quantity and value of the stock.

### PURCHASING RECORDS

Requisitions for the purchase of goods used to be made on a variety of blanks, on odd pieces of paper and even by word of mouth. In place of all this, two regular forms were substituted, one for open orders and one for contracts. When filled out they show what is wanted and the estimated cost, where it is to be delivered, the use to which it is to be put, the date it will be needed, and a statement signed by the man ordering the goods and certified to by his bureau superiors that the materials so ordered are for the use of the city and are necessary. These requisitions are then investigated to see: First, if the goods can be supplied from stock on hand in storerooms; second, if there is any already ordered; third, if the quantity appears to be correct; fourth, if the quality appears to be right for the use intended; fifth, if there is a department specification for the goods, and if not, whether the requisition clearly describes what is wanted.

The determination of these matters called for a perpetual inventory of goods on hand, so that was arranged for under the storage records.

Forms were then prepared which greatly facilitated the work of making the purchases and a ledger was started to show the state of forwardness of any contract, whether with the Corporation Counsel or with the Comptroller, or with the "City Record" for printing. Its records of the dates when papers were sent and when returned furnished the data for a most interesting and instructive diagram which accounts for the time taken in letting a contract. The purchasing records also show what has been bought, for whom it was bought, and the cost.

A ledger was recently begun to show whether goods ordered have been delivered, if so, whether they have been inspected, and if inspected, the result. If goods are rejected, the contractor is notified, the date of replacement noted, the time required to reinspect recorded, and whether the goods passed or failed to pass. All these facts are put down and used as required.

### STORAGE AND ISSUE RECORDS

The establishment of a proper stores control is to be reckoned among the most important achievements of the past two years and a half. The storerooms have records showing what goods were received, from whom received, what goods were issued, to whom issued and the amount of stock on hand.

The reports of goods received and issued from storehouses sent daily to the central office, together with duplicates of all invoices, requisitions on stores, transfers, loans, and so forth, make possible a system of accounting where the control ledgers at headquarters can exercise the most perfect check on the accounts kept at the storehouses. The present system assures the auditor of the fact that all bills presented to him for payment are only for goods actually delivered, inspected and passed. Finally, the present records show, day by day, the quantity and value of all stores under the charge of the Bureau of Supplies.

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# "Don'ts" for Fireproof Construction

A COMPILATION of a series of "don'ts" for the use of architects, engineers and builders by one of the six subcommittees of the National Association of Fire Protection committee on fire-resistive construction will present warnings against the principal errors in design and construction. Recent collapses of buildings during construction have augmented the fear that some of these fire-resistive buildings will fall when occupied and cause a disaster which will handicap fireproof construction. Architects, engineers and builders are being interviewed in a friendly way and cooperation is desired and solicited by Mr. W. G. Sanderson, of Chicago, chairman of the subcommittee.

## Economy in Cleaning Catchbasins

### Motor Truck Fitted with Orange-Peel Bucket and Boom in Use by Pawtucket Municipal Department

A REDUCTION of 57 per cent in the cost of cleaning catchbasins resulted from the use of a motor truck fitted with a small orange-peel bucket and a centrifugal pump. This was accomplished by the Department of Public Works at Pawtucket, R. I., a city of 54,000. The apparatus was developed entirely within the department.

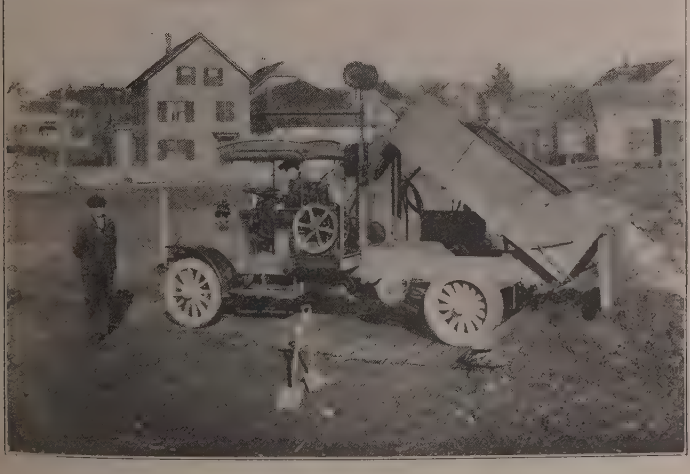
The equipment in its present form is carried by a Standard 3-ton chassis with a 32-hp motor, on which is mounted a dump body of the following dimensions: Length, 9 ft.; front width, 4 ft.; rear width, 4 ft. 9 in.; height, 2 ft. 4 in. Between the driver's seat and the truck body are a hydraulic lift which dumps the body, an iron mast carrying the revolving boom from which the 2-cu. ft. orange-peel bucket is suspended, a 70-gal.-per-minute centrifugal pump for emptying surplus water from basins, a 2-hp Fairbanks-Morse gasoline engine, and the necessary gears, pulleys and drums. The small engine raises and lowers the orange-peel bucket by a hoisting drum, drives the centrifugal pump and runs the oil pump for the opening and closing device on the bucket. The hydraulic hoist is operated from the motor. One tank supplies gasoline to engine and motor.

The truck rests on a 12-ft. wheelbase. The height of the equipment to the top of the crane is 9 ft. 3 in.; the length over all is 18 ft. 6 in. The weight of the truck empty is 10,600 lb.; the weight loaded is 18,400 lb.

### COST PERFORMANCE

By the old horse-and-cart method the cost per cubic yard of material to the dump, which involved an average haul of 4000 ft., was $2. The truck without the pump or the orange-peel bucket was put into service July 17, 1913; the catchbasin was emptied by a man inside with a shovel, a plain bucket being used. The cost soon dropped to $1.05 per cubic yard. The orange-peel bucket was put into operation Nov. 17, 1913, since which time the charge has been 86 cents, interest and depreciation included. It will be seen that the total cost reduction has been 57 per cent; the worth of the orange-peel bucket and pump is shown in an 18 per cent decrease. About 20 cu. yd. per day were handled. Four men accompany the apparatus—three laborers at $10.80 per week and a driver at $16.50 per week.

The hydraulic hoist and bucket were built in the municipal shops, where the apparatus was assembled. The device was originated by Mr. Joseph Wood, assistant commissioner of public works, whose plans were carried into execution and developed by Mr. James Nisbet, mechanician in the department.



Orange-Peel Bucket Swung Clear While Dumping Body

Hoisting Loaded Orange-Peel Bucket from Manhole

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## Asphalt Repairs in Dayton

### Cost Analysis of Seven Days' Operation of Portable Plant

DURING a test of a new portable asphalt repair plant at Dayton, Ohio, from Dec. 1 to 8 inclusive the costs ranged from 36 to 51 cents per square yard. Old materials were used in a Smith mixer. The following table of costs was obtained by Mr. C. O. Dustin, staff engineer, of the Bureau of Municipal Research, Dr. L. D. Upson, director:

OPERATION STATISTICS AND UNIT COSTS WITH OLD ASPHALT

| Date | Hours plant run | Number batches mixed | Minutes required per batch | Cu. ft. mixed | Sq. yd. laid | Total cost | Cost per sq. yd. |
|---|---|---|---|---|---|---|---|
| Dec. | | | | | | | |
| 1 | 5 | 14 | 21 | 210 | 84 | $32.60 | $0.39 |
| 2 | 9 | 32 | 17 | 480 | 194 | 70.35 | 0.36 |
| 3 | 9 | 39 | 14 | 624 | 197.5 | 84.10 | 0.43 |
| 4 | 9 | 40 | 13.5 | 640 | 203 | 88.10 | 0.43 |
| 5 | 6 | 29 | 14 | 464 | 115.5 | 57.30 | 0.51 |
| 6 | 9 | 34 | 15 | 544 | 173 | 69.40 | 0.40 |
| 8 | 9 | 21 | 22 | 384 | 123 | 59.35 | 0.48 |
| Total .... | 56 | 212 | .. | 3346 | 1086 | $461.20 | .... |
| Average . | .. | ... | 16 | 557 | 181 | 25 | 0.42 |

These costs, calculated to a 2-in. equivalent, would be about one-half of the above figures, as most patches were 4 in. thick.

Mr. Dustin reports that it was impossible to obtain a definite proportion of aggregate and bitumen when remelting old material, but analysis of early runs indicated 17 per cent bitumen. As the city specifies 10 to 13 per cent bitumen, the amount of new asphaltic cement was reduced somewhat. He is of the opinion that the costs of laying asphalt using old material can be greatly reduced in the summer season with a more efficiently organized crew.

The unit costs per square yard of paving actually covered were: Coal, 2.5 cents; asphalt (standard paving), 3.4 cents; crushed stone (used 3 days only), 0.7 cent; marble dust, 0.2 cent; total for materials, 6.8 cents; plant and truck, 10.8 cents; laying, 20.3 cents; undistributed, 4.6 cents; total labor, 35.7 cents; grand total, 42.5 cents.

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## Paths of Sewage Currents in New York Bay Tested

### Results of Float Observations by Metropolitan Sewerage Commission

AN artificial island to be built 3 miles out at sea to provide an area for treating the sewage of New York City was proposed in one of the Metropolitan Sewerage Commission's preliminary reports (see Engineering Record of April 26, 1913, page 475). Since this recommendation was submitted the commission has made a number of observations with floats to determine the transporting effects of the tides in lower New York bay upon sewage from the proposed outlet island, located midway between Sandy Hook and Rockaway Point. As a result of these float observations the following conclusions have been reached:

1. The shores of lower New York bay would be in no danger of pollution if sewage was to be discharged at the site of the proposed island.
2. On flood currents floating sewage would seldom, if ever, reach the Narrows and would not pass into the upper bay.
3. There is no set of tidal water capable of carrying sewage from the site of the proposed island toward Rockaway Beach or inlet nor toward Coney Island on flood or ebb currents.
4. There is a resultant motion seaward from the vicinity of the proposed island and particles carried out to the whistling buoy or further will not return.
5. Floating particles will be repelled from Gravesend Bay.
6. Little sewage, if any, will cross Ambrose Channel, and that which does cross will proceed outward from the Narrows on the ebb current and will have a tendency to return by the same route.
7. The proportion of sewage from the island which is capable of reaching Raritan Bay is small and has no tendency to remain in the bay.

# Highway Work in Massachusetts

Statement Covering Construction and Maintenance by the Massachusetts Highway Commission during Year Ended November 30, 1913

THROUGH the courtesy of the Massachusetts Highway Commission an outline of the work of the board for the year ended Nov. 30, 1913, is presented below. The board consists of the same members who served a year ago. Col. William D. Sohier, chairman, was reappointed and continued as chief executive of the commission. In the highway department are employed from 20 to 60 engineers, draftsmen, instrument men and rodmen, depending upon the season of the year and the amount of work on hand. The state is divided into four divisions, with headquarters at Springfield, Greenfield, Middleborough and Boston, and most of the principal engineers and their assistants have been in the service of the state for at least ten years.

### FINANCES

During the year the board completed work on 49.25 miles of state highway, portions of which were laid out in 1912. Construction was begun on over 31 miles of roads in 30 towns, and layouts were made of about 60 miles of state highway in 62 towns. At the end of the year the total length of state highways was 981 miles. The total expenditures of the commission for state highway construction since the work began, including tree planting, is $1,241,218. The counties pay to the state 25 per cent of the cost of building these roads. The money so repaid has been used in the reduction of the bond issue, and consequently the state bonds are outstanding for a much smaller sum. The Legislature of 1912 authorized the expenditure of $5,000,000 during the next five years at the rate of not over $1,000,000 per year. Of this amount, $150,000 is to be expended upon so-called "small town" roads, $100,000 of which is only available in case the towns contribute a like amount. There are now on file 920 petitions covering 2175 miles of road in 324 municipalities. Many cities and towns have made appropriations to be used with money furnished by the commission and expended in building roads.

This year the amount available and expended for state highway and small town road construction is about four times the amount five years ago. In 1913 $1,000,000 was available for construction and maintenance of these roads; $713,000 was available for the maintenance of state highways from the tax levy and from motor-vehicle fees fund. A grand total of $2,693,000 was available to be expended under the board's direction, and something over $3,000,000 expenditure in all is to be made under the supervision of the commission, and under specifications furnished to municipalities where they construct roads and bridges with their own money. The entire force has been taxed to the utmost.

### WIDER MAIN ROADS

The board has continued its policy of making the main roads wider, usually building 18 ft. of stone surface instead of the former standard of 15 ft. It has also continued on such roads to use some bituminous binder in construction and has been reducing the crown of the road to about 1 in. per yard in width, making the road less slippery and also better distributing traffic. This additional width and the bituminous binder which must be used increase the cost of construction from 50 to 75 per cent. The eight-hour law and workingmen's compensation act have also largely increased the cost. The increase in traffic, and especially in motor vehicles, makes this additional width and more expensive construction absolutely necessary.

Of the state roads completed in 1913, 22.25 miles were of bituminous macadam; 9.5 miles, water-bound macadam, which is or will be coated with some bituminous binder; 4 miles were of gravel; 4.75 miles of sand bound with heavy asphaltic oil; 3.25 miles of macadam coated with hot asphaltic oil; 3 miles of bituminous gravel; 2 miles of concrete, and 0.5 mile of granite block on a concrete base. Further details are given in the accompanying tabular summary of costs.

The state highway in Holyoke was too narrow for its traffic, which includes many motor vehicles, and under the direction of the board this was increased to a width of 18 ft. of hardened surface for a distance of 4 miles. Some of the road was only 12 ft. wide. The work was done by contract and resurfacing was included. The old road was scarified, as much new stone rolled in as was needed, and the whole road coated with a bituminous binder. On a portion refined tar was used, and on part a heavy asphaltic binder. The work was done in six weeks at a cost of $24,000. On the line between Boston and Salem, in Revere and Saugus, the state highway over salt marshes was rebuilt by using a bottom of granite blocks grouted with concrete and laid upon a concrete base, the local traffic including from 50 to 75 motor trucks daily.

In North Andover the old highway ran over a bad bottom and drainage conditions were very poor. A concrete road was built here, largely as an experiment. The commission expects the road will be thrown somewhat by frost and that cracks will develop, but it anticipates filling the latter with tar and sand as in Detroit practice. At North Andover a bituminous macadam road would have required much more excavation and a foundation of stone or other suitable material, which would have resulted in a greater cost. The board feels that some reasonably economical method of building roads that will stand up and carry a tremendous motor vehicle traffic and be strong enough not to break up under it must be discovered in the near future, or the roads will rapidly be destroyed.

In 1906 the board built 0.5 mile of concrete road in Spencer, the grouting method being used, and this road is now in good condition. This first concrete road was only 15 ft. wide and had a crown of about ¾ in. per foot. There were many complaints of its being slippery for horses, largely on account of the crown. While most of the concrete wore well, some small holes developed, and these were patched with tar. In 1908 this road was coated with refined tar covered with sand or pea stone, both to prevent the further development of pot holes and to give a better footing. This surface wore well and required only slight patching until 1910, when another application of refined tar was made. A third application was made this year. The traffic is largely by automobiles.

### SAND CLAY CONSTRUCTION

By the use of sand and oil the whole length of the Cape road to Provincetown has been made passable during the last four years, but constant care will be required to maintain it. On Martha's Vineyard a road largely to be used by automobiles is to be built in Chilmark and Gay Head. A portion is to be built of sand and clay, under suggestion of Mr. Logan Waller Page, director of the U. S. Office of Public Roads. An engineer from this office is superintending this construction. The commission states that the experiment will be watched with great interest, and if a satisfactory road of sand and clay can be built and maintained in this climate the expense of such construction is only a fraction of the cost of a macadam road and is probably much less than that of the sand and oil road.

The board feels that the co-operative work performed by itself and town officials, where the town takes the contract and performs the work, the board furnishing the specifications and engineering supervision, is the most valuable accomplishment of its engineers.

Some of the state highways are 20 years

APPROXIMATE COSTS OF GRADING AND DRAINAGE AND MILEAGE OF ROADS COMPLETED IN 1913

| Town | Type of surface | Basis of calculation | | Drainage culverts and bridges, total cost | Grading and foundation, cost per mile | Cost of surface | |
|---|---|---|---|---|---|---|---|
| | | Miles | Sq. yd. | | | Per mile | Per sq. yd. |
| Acton | Macadam, 5-in. local stone, bituminous binder | 1.13 | 11,933 | $783 | $4,880 | $8,182 | $0.77 |
| Acton, 1912 | Macadam, 5-in. local stone, bituminous binder | 0.64 | 5,632 | 1,405 | 2,554 | 7,272 | 0.82 |
| Amherst | Macadam, 5-in. trap rock | 0.79 | 6,952 | 1,099 | 4,390 | 5,950 | 0.67 |
| Becket, 1912 | Macadam, 5-in. local stone | 1.39 | 12,232 | 1,883 | 9,246 | 4,502 | 0.51 |
| Charlton | Macadam, 3½-in. local stone | 0.87 | 7,656 | 358 | 3,855 | 3,301 | 0.37 |
| Charlton, 1912 | Macadam, 4-in. local stone | 1.24 | 10,912 | 741 | 4,130 | 3,811 | 0.43 |
| Grafton, 1912 | Macadam, 6-in. local stone, bituminous binder | 1.64 | 14,432 | 2,465 | 2,742 | 4,919 | 0.55 |
| Lanesboro | Macadam, 3½-in. trap rock, bituminous binder | 0.23 | 2,024 | 45 | 5,611 | 7,900 | 0.89 |
| Littleton-Ayer, 1912 | Gravel, 4-in. macadam, 2-in. local stone, bituminous binder | 0.99 | 8,712 | 774 | 3,628 | 5,940 | 0.67 |
| Mashpee, 1912 | Sand and oil, 3-in. mixed | 1.35 | 12,617 | 305 | 1,847 | 5,044 | 0.54 |
| Middleton, 1912 | Macadam, 5-in. local stone, bituminous binder | 0.61 | 6,442 | 357 | 6,572 | 9,414 | 0.88 |
| Northfield-Gill, 1912 | Gravel, 6-in. | 2.16 | 19,008 | 2,843 | 5,445 | 2,500 | 0.28 |
| Northfield, 1912 | Macadam, 5-in. local stone, concrete bridge | 1.24 | 10,912 | 6,000 | 8,941 | 5,480 | 0.62 |
| Plymouth, 1912 | Sand and oil, 3-in. mixed, grading and drainage, finished 1912 | 1.58 | 14,767 | .... | .... | 5,171 | 0.55 |
| Seekonk | Macadam, 4½-in. local stone, bituminous binder | 0.76 | 6,688 | 62 | 4,971 | 7,334 | 0.83 |
| Sterling, 1912 | Gravel, 6-in., bituminous binder | 1.41 | 12,408 | 320 | 2,491 | 5,640 | 0.64 |
| Sunderland | Macadam, 5-in. trap rock, concrete bridge | 0.98 | 8,624 | 1,609 | 1,916 | 6,700 | 0.77 |
| Westford, 1912 | Gravel, 5-in. | 1.86 | 16,368 | 527 | 1,930 | 1,496 | 0.17 |
| West Springfield, 1912 | Macadam, 4-in. trap rock, bituminous binder | 0.74 | 7,814 | 520 | 7,671 | 7,305 | 0.69 |
| Wilbraham | Macadam, 4-in. trap rock, bituminous binder | 0.25 | 2,200 | 2,398 | 2,200 | 7,079 | 0.80 |

old, the average age being 10 years. They are rapidly becoming worn out and are not strong enough to withstand the heavy modern traffic. Many miles of road formerly built of macadam or gravel, from 12 to 15 ft. in width and from 4 to 6 in. in depth, are inadequate, the corners and curves being unsafe for motor vehicles. The roads need widening, improvement of corners and curves, and resurfacing with some permanent form of construction, the cost being estimated at from $8,000 to $10,000 a mile, or in a few years many miles of state highway on the heavily traveled roads will suddenly go to pieces. The work should be planned and begun now, and at least 100 miles a year should be widened and reconstructed. During 1913 the board expended over $700,000 in maintaining state highways, of which $500,000 was secured from the motor vehicle fees fund. Bituminous materials were used in maintaining 501 miles and 33 miles were resurfaced. At present bituminous materials have been used, either on the surface or in construction, on 881 miles of state highway out of the total of 980 miles. Over 2,500,000 gal. of such material have been used. The surface of the state highways is, as a whole, in better condition than ever before. On many miles of road, where there was only money enough to allow the use of a small quantity of light oil last year, merely laying the dust, a second coat of sand and oil has been applied this year, which, when covered with stone or sand, has materially improved the surface condition. Such treatment is recognized by the board as merely a temporary expedient.

The table on page 112 gives the costs of draining and drainage, separated from surface costs, on roads completed by the commission in 1913.

# Letters to the Editor

## Specifications for Factory Timbers

SIR: A paper by Mr. F. J. Hoxie, read before the American Society of Mechanical Engineers recently [abstracted in the Engineering Record of Jan. 17, page 66], entitled "Specifications for Factory Timbers," has just come to my attention. This paper, I think, is liable to inflict an unnecessary hardship on the lumber industry and users of wood. For this reason, therefore, I should like to contribute a few remarks and should be glad to have them printed in your publication.

Mr. Hoxie's paper is very interesting and certainly hits upon a live problem. He concludes, among other things, as follows:

"(a) The percentage of resin in hard pine can be taken as an index of its power of resistance to rot, 3 to 5 per cent being the lower limit."

I believe that this suggestion has little practical value except for unusual conditions, first, because of the difficulty of making the tests, and, second, because of the great variability of the distribution of resin that occurs even in a short stick of wood. Furthermore, the decay-resisting powers of resin are still problematical, although, without doubt, it tends to retard the growth of these organisms, probably along physical lines. The amount of resin necessary to prevent the development of fungi apparently is unknown. We have reason to believe that resin in wood strengthens it, other things being equal. Therefore, the presence of resin in timber is desirable from the standpoint of durability and strength. To specify its amount and to provide for its analysis, is, however, of questionable practical value for the reasons stated.

Mr. Hoxie in his conclusion further states:

"(b) Hard pine lumber 12 in. square or larger is not obtainable in quantities with sufficient natural resistance to withstand fungus in a moist location."

I believe that this statement is too sweeping. There are millions of feet of virgin longleaf pine growing in the South. It seems to me that a difference of fifteen, or even fifty years in the age of this timber can have very little effect upon its quality when a large percentage of it is several centuries old. There is no doubt whatever that the same quality of longleaf pine obtained in the past can be obtained now without undue trouble or expense. I should think that this would be clearly illustrated to any one who would watch the quality of our longleaf pine now being exported. I believe that the securing of this timber is solely a matter of proper specifications, rigid inspection, and willingness on the part of the consumer to pay a higher price for a higher grade article. As just mentioned, excellent qualities of longleaf pine are now being exported. Why cannot similar qualities be used in our own country?

Mr. Hoxie's last conclusion, which reads, "(d) The only hard pine which is now obtainable in suitable quantities is not safe to use for the important parts of a mill without antiseptic treatment," I believe is also unwarranted, largely for the reasons given under quotation (b). There is no doubt that the antiseptic treatment of timber used in buildings is of great and growing importance. As Mr. Hoxie states, the problem of treating such timbers is quite different from treating ties and posts. I believe, however, that it is a problem capable of solution. The standard impregnation treatments with creosote and zinc chloride are satisfactory for many requirements, but fail for others—as, for example, when the treated timber is exposed and requires painting. In such cases it might be found desirable to cover treated timbers with thin boards of untreated wood.

The manner in which structural timbers, and other forms of timber for that matter, are now being marketed seems to me capable of great improvement. Wood is one of the few structural materials which are seldom branded. I believe that all structural timber, especially for buildings, should be branded by the manufacturer. This brand should contain at least the manufacturer's name and the State in which the timber grew; preferably the grade of timber should also be stamped upon it, this grade being certified to by some competent body such as is already in existence. We are all familiar with the splendid progress made by certain fruit growers as a result of branding their products and insisting upon certain quality. As conditions are at present in the lumber business the manufacturer who produces a high-grade product is suffering from the activities of the manufacturer who produces a low-grade product. It is practically impossible to tell structural timbers cut from various Southern pines apart except by microscopical examination of each piece, and even this test is not infallible. Specifying the minimum number of rings per inch is of assistance, but does not go far enough. I believe that the scheme suggested would be of considerable assistance to engineers, inspectors and consumers, and result in placing more confidence on their part in the timber they are getting.

A number of other woods are now being mixed in with the Southern pines and are sold with them apparently without distinction. In the Forest Products Laboratory we have frequently received Norway pine on contracts in which we called for longleaf pine. Our experience, I dare say, is rather indicative of what is now taking place. I recommend the suggestion of branding structural timber for the serious consideration of all manufacturers of structural timber; also to engineers, architects and builders. I believe that if this is done they can place certain brands of lumber in an entirely new light, the same as has been done for certain varieties of fruit, and that it will remove the basis for much of the dissatisfaction with timber now experienced by Mr. Hoxie and others.

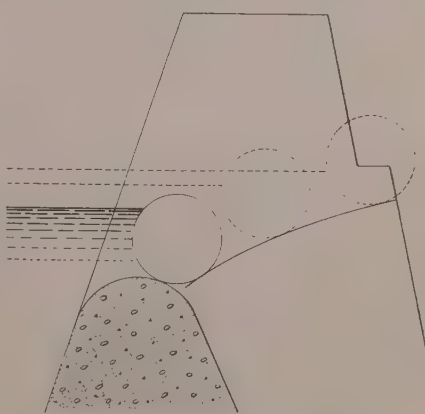
HOWARD F. WEISS,
Director Forest Products Laboratory.
Madison, Wis.

## Rolling Dams

SIR: In the article on the advantages of the rolling dam in the Engineering Record of Nov. 22, 1913, page 564, a statement is printed of the electric power required to operate the rollers in the Long Lake design.

Why use electric power? Why not use the pressure of the water against the rollers as a source of power for their operation? A comparatively slight variation in the elevation of the water surface would furnish the required amount of power if the tracks upon which the rollers move were given the proper vertical curve. These tracks would have their greatest inclination at their upstream end, this inclination being just great enough to hold the roller upon the crest of the dam when the water surface is a few inches below the top of the roller. A rise in surface of the water of the reservoir would then cause the dam to roll upward to a point on the track where the inclination would be less and the consequent relative position of the water surface upon the rollers would be lower.

In this way the rollers moving up over the constantly decreasing inclination of the track would rise many times faster than the surface of the reservoir and a comparatively small fluctuation of the reservoir



Proposed Arrangement of Roller

surface would effect the complete opening or closing of the dam.

New York City. J. E. JENKINS.

## Collapse of Concrete Building at Cedar Rapids, Iowa

SIR: The account of the collapse of a reinforced-concrete building at Cedar Rapids, Iowa, while under construction, as given in your issue of November 29, 1913, although it does not fix the responsibility of the accident helps to add emphasis to the fact that reforms must be forthcoming in reinforced-concrete and tile-and-concrete designs, if the popularity of these types is to be maintained.

The rapid growth of the concrete industry has necessarily given rise to a great deal of commercial designing, that is, designing by firms selling reinforcing steel, who make up so-called detail plans and furnish them together with the steel, in many cases at a price but little above the market price of the steel alone. This means that in order to get work these firms must use every available means of cutting down the amount of steel required, so that their bid may be lower than that of some competitor. Knowing that when properly designed reinforced-concrete structures have a factor of safety of three or four, these unscrupulous designers at once pare down this factor as much as they dare or as much as they think necessary in order to "land" the job. In this organized gang of "flirting with the factor of safety" the man who is willing to take the most chances is the one who overcomes his competitors and gets the business. Altogether too much competition is based on what can be taken from the factor of safety, and for this reason it might be well to change this useful engineering phrase to the "factor of competition," so as to state the truth of the matter insofar as commercial designing is concerned.

With these facts in mind it is not at all surprising that we read of failures of concrete buildings, for nothing invites failure as much as a "skinned" design coupled with poor workmanship which is very likely to be obtained on such a job.

Commercial designs for combination tile-and-concrete construction are very numerous, and are generally characterized by high allowable unit stresses in steel and concrete, insufficient steel over supports to care for negative moments (no doubt in many cases due to erroneous assumptions as to moment coefficients), and neglect to consider that at the supports of the ribs, where they are continuous, the rib is a rectangular beam and not a T-beam, thereby allowing excessive compression in the concrete. The writer does not wish to be understood as saying that these faults existed in the structure mentioned above, since he has not seen the plans and is, therefore, not in a position to comment on this particular case; however, in all designs which he has examined, these conditions have invariably prevailed and are cited as points to be watched in such designs.

A large percentage of the failures of concrete buildings are among those of the tile-and-concrete type, as can be found by going over the records of failures. This would seem to indicate that this type of construction is one which requires very careful consideration of those details of design which, when neglected in all-concrete designs, are not followed by such serious circumstances. This does not mean that tile-and-concrete designs cannot be made which are safe as well as economical, for there are a great number of buildings of this type which, having been properly designed, are giving excellent service. The one-way beam and slab type of concrete-and-tile construction, however, is by no means as conservative as a two-way system since any inequality of loading or piece of poor construction manifests itself in the overstressing of certain members, which, unaided by any balancing conditions tending to redistribute the stresses, is liable to cause sudden failures.

Another feature which bears watching is the design of reinforced-concrete columns. Twelve-inch columns for story heights of 10 or 12 ft., reinforced with vertical bars only, are not uncommon in cities where no building codes are in force. Columns of this size are entirely too small for such important members; the stresses may be low enough, but the danger of having stone pockets occur with consequent weakening of the column is much greater than in larger columns. Then again, if the building is narrow, stresses due to wind pressure may seriously overstress a slender column.

Concrete columns reinforced with vertical bars and occasional ties, say from 12 to 18 in. on centers, have been shown by tests to be in some cases even weaker than a plain concrete column, on account of the splitting and buckling actions caused by the combination of longitudinal bars and concrete under stress. In spite of this truth, there are hundreds of buildings in this country with columns built in this manner. This cannot be called good design, but such things occur every day in commercial design, for the fact that the unit compressive stresses are not exceeded will make the designer waive all claim to practical consideration and common sense in his mad rush to cut down the cost of the building.

The basic principle of the commercial design is fundamentally wrong, for it tries to combine two functions which at the present day are striving toward diametrically opposite goals. In other words, the purpose of commercial design is to aid the cause of the contractor, that of erecting a structure at the least possible cost by cutting down the amount of steel and concrete to a dangerous minimum; while the purpose of an engineering design is to obtain a safe and economical construction without sacrificing strength in any part. An engineering design based on good practice with the usual factor of safety should not be subjected to such a "weeding out" of all steel which, on account of the radical assumptions of the commercial designer or contractor, does not appear to be required.

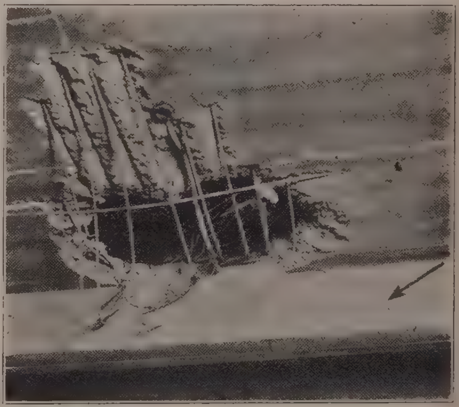
The use of commercial designs has been given a great impetus because of the fact that many firms purchase buildings through their purchasing agent in much the same manner as they buy supplies. In general, purchasing agents are not technical men and therefore do not appreciate the fact that there are other things besides cost to consider in building design. For instance, if they were compelled to choose between a good engineering design and a poor commercial one with a difference of $1,000 in cost in favor of the latter, they would, in nine cases out of ten, accept the cheaper one, since their sole idea seems to be in making a good showing by immediate savings and not considering ultimate results.

If owners, architects and builders would retain capable engineers to design structures and not try to save a few dollars or a small percentage on the cost of the building (which would be the engineer's fee) by obtaining cheap commercial designs made by firms selling the steel and giving the plans much in the same manner as trading stamps are given by department stores, as an extra inducement to customers, the standard of concrete building design would be raised to a much higher and safer plane. It, therefore, is the duty of the engineer to impress upon the owner and architect the necessity of doing away entirely with purely commercial designs.

Chicago. ALBERT W. WOLF, C.E.

## Impact Breaks Concrete Floor

SIR: An unexpected test of the strength of a reinforced-concrete floor took place on Oct. 17, 1913, in the First National Bank Building at El Paso, Tex. While a piece of elevator machinery weighing 3275 lb. was being hoisted to the roof through the skylight of a two-story portion the rope snapped and the load dropped 85 ft. The impact broke the floor, as shown in the photograph, but the reinforcement held the piece of machinery 1 ft. below the floor level.



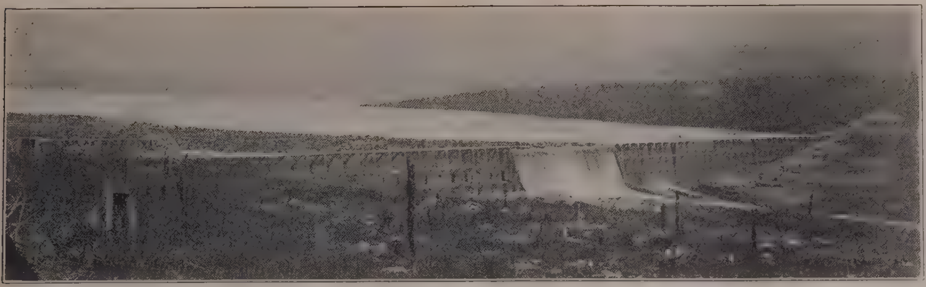
Broken Floor and Cracked Beam

The floor slab tested in this most unusual manner was 5½ in. thick, made of 1:2:4 mix and provided with a main reinforcement of ½-in. square twisted bars spaced 6 in. on centers and a temperature reinforcement of ⅜-in. square twisted bars spaced 30 in. on centers. All rods were bent up over supports.

The only damage to the adjoining beam was a small crack beginning at about a quarter of the span from the right end and continuing to the top of the beam toward its center, as indicated by the arrow. This beam was 14 x 24 in., reinforced with four ⅞-in. square twisted bars, two being bent and two straight. This beam was afterward tested with a load of 15,000 lb. without showing any appreciable deflection.

Pieces taken from the three broken rods were tested to a rupture, which occurred at a maximum unit stress of 78,000 lb. and a reduction in area at place of rupture of 50 per cent. The concrete had been originally figured for an extreme fiber stress of 750 lb. per square inch and the steel for 20,000 lb. The building was designed by Trost & Trost, of El Paso, of which firm the writer is a member.

El Paso, Tex. ADOLPHUS G. TROST.



Downstream View, Looking West, of Stony River Dam before Failure

# Failure of Stony River Dam

## Water, Undermining Cutoff Wall, Washes Out Foundations and Five Bays of Hollow Reinforced-Concrete Structure Are Swept Away by Flood

UNDERMINING of the foundation of the West Virginia Pulp & Paper Company's hollow reinforced-concrete dam across the Stony River at Dobbin, W. Va., caused the collapse at 12.15 p. m. on Jan. 15 of five bays of an Ambursen structure, which was 1065 ft. long, including the earth abutments, and 51 ft. in maximum height. Happily the dam was located in a wild, unsettled region, so that the wall of water which passed through the breach and surged onward down the valley to the Potomac River took no toll in human lives, although the flood completely demoralized traffic on the Western Maryland Railway and caused a panic among the inhabitants of the towns of Schell, Luke and Piedmont, many of whom, as the stage of the water rose, fled into the hills to reach points of safety.

At first it was feared that the terrible calamity which occurred at Austin, Pa., two years ago was about to be repeated, but the force of the flood was dissipated to a large extent in its 19-mile journey from the dam to the nearest habitations. The damage was confined principally to the dam itself.

From the evidence on the ground, the collapse of the dam was caused directly by water which found its way under the cutoff wall, which had not been sunk to a sufficient depth to form an adequate seal. This water, flowing below the base of the structure, scoured out the material upon which the dam rested and formed a huge cavity. The unsupported section then broke and fell, allowing the water stored behind it to rush through, tossing huge fragments of shattered concrete downstream.

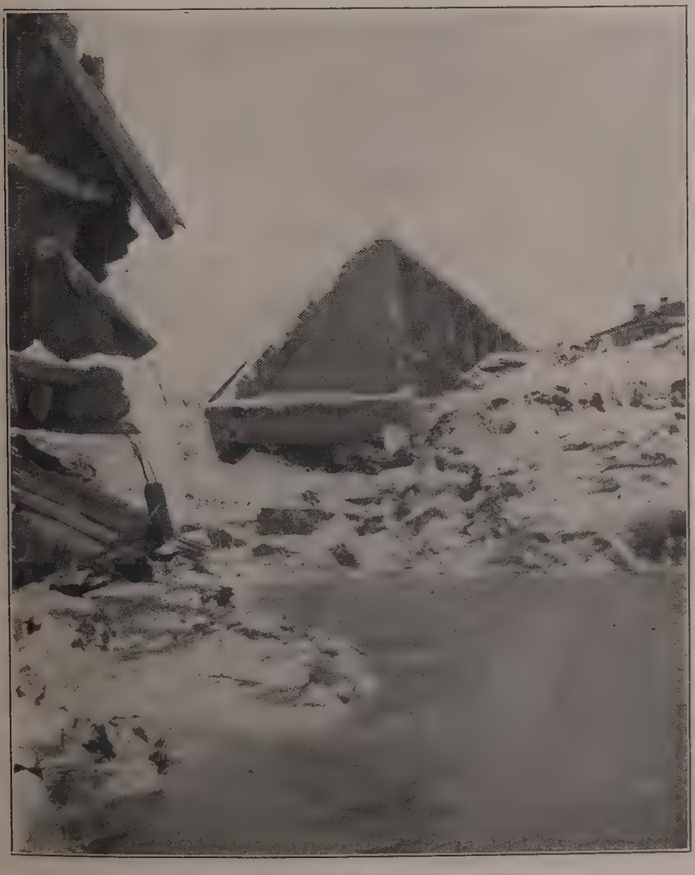
### FEATURES OF DAM

The Stony River dam was built for the West Virginia Paper & Pulp Company to regulate the flow of water in the Potomac River at Luke, Md., where water is needed by the company's mill. The drainage basin above the dam is about 12 sq. miles, the area of the reservoir when full is 480 acres and the storage 3,000,000,000 gal. The dam is of the Ambursen type and has sixty-six 15-ft. panels supported on sixty-seven buttresses 18 in. thick. Of these panels ten form a spillway with a crest 3 ft. below the top of the dam. The dam has a continuous floor, 1 ft. thick, on which the buttresses are supported. Water passing over the spillway is led through a concrete channel into the old bed of the stream. Water topping the dam crest at other points, due to wave action, is collected in a concrete gutter below the dam and carried to the concrete channel from the spillway. At the ends the dam has earthfill abutments, so that the total length of the dam is about 1065 ft. The maximum height of the dam above ground is 51 ft., and the deepest point of excavation of the cutoff wall is 42 ft. below the floor. Maximum distance from top of dam to deepest point of excavation is 81 ft. The accompanying drawing shows the rear elevation of the dam and the respective depths of its cutoff wall.

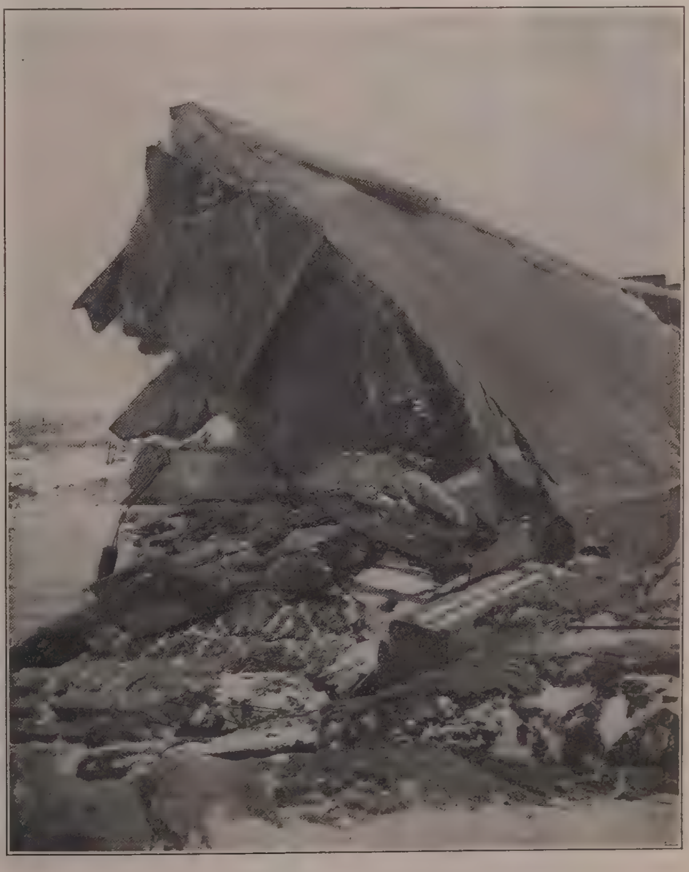
Investigation of the foundation was made by twenty-two test pits, sunk on the axis of dam. These pits were 6 to 8 ft. square and carried down to rock. Only three pits were dug west of the point where the break occurred, 22, 20 and 18 ft. deep respectively, none of them reaching rock. The nearest pit of the break was 200 ft. west from it. In this pit augers were sunk 14 to 16 ft. deep and the material was examined. No rock was found, although the depth reached was 36 ft. below the surface of the ground.

### DIFFICULT TRIP TO DAM

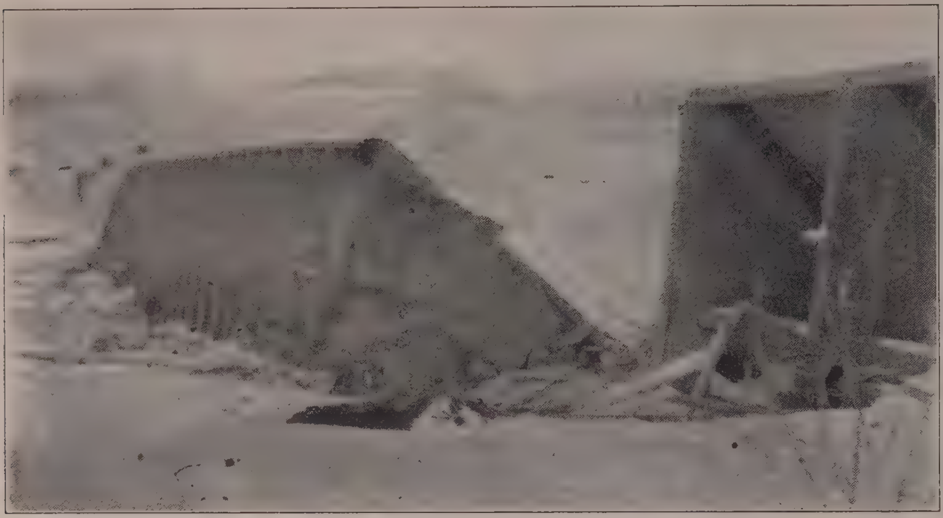
When the news of the disaster was received a representative of the Engineering Record was dispatched to the site of the dam. He arrived in Dobbin, W. Va., at noon Saturday, Jan. 17. By the shortest route the dam is 15 miles from that town and can be reached only by a logging road, over which a train runs once daily. A blizzard was whipping the snow across the bleak



Breach in Dam, Looking West, Showing Washout



Looking East—Fragments of Deck Slab and Floor



Appearance of Break Looking East from Downstream Side

Virginia hills, darkness was approaching, the temperature was falling steadily, and any attempt to press onward on foot would have been against great odds. The only alternative was to remain in Dobbin overnight and hope for more favorable conditions the next morning.

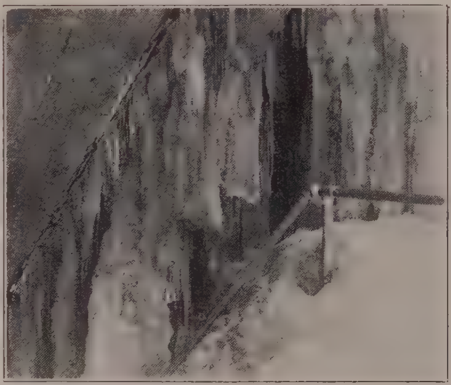
At 5 a. m. Sunday the storm had abated, and a start was made on foot, for the logging train had been snowed up in the mountains and it was uncertain when it would start running on its regular schedule. With snow 4 ft. deep in places the 15-mile hike over hills was negotiated in 7 hours. It was extremely hard going and speed was reduced, for at each step one sank through the crust thigh deep. The goal reached, a careful inspection of the break was made, the locations of shattered fragments of the structure were plotted and many photographs taken. The pictures are reproduced herewith.

### Leakage Observed before Failure—Outlet Valves Frozen

A watchman and his wife live in a cottage at the west end of the dam, and from them the facts as to what occurred prior to the washout were learned. A leak was noticed west of buttress 13 on Wednesday, Jan. 14, and as the dam was connected by telephone with the pulp mill at Luke, Md., the watchman informed the superintendent of this fact at 6.30 p. m., stating that all outlet valves in the dam were frozen and could not be operated. The superintendent immediately started for the dam, arriving there during the forenoon of the following day. By that time the undermining of the dam had progressed so that a cavity 30 to 40 ft. wide had been washed out and the opening spanned by the dam; about 5000 sec.-ft. were rushing through the hole. The eroding force of the water was checked at the east side of the hole, about 9 ft. west of buttress 16, where the cutoff wall had been carried down to bedrock.

### Buttress 13 Settles

At 12.15 p. m. buttress 13 began slowly to settle until the sag in the crest was about 12 in. Then it rotated clockwise until its bond with the deck slabs had been broken. During this period the pond level was lowered 2 ft. from El. 136 to El. 134. The buttress with parts of the slabs then gave way and seemed to float downstream, following a path which curved to the right, or eastward. It is now located about 150 ft. downstream and 50 ft. east of its original position in the dam. It is a tangled mass of broken concrete and bent and twisted steel bars, as shown in one of the photographs. Some of the bars project $8\frac{1}{2}$ to 14 ft. from the buttress, but as far as could be observed none was ruptured. These bars were the main reinforcement of the slabs, and although they are $\frac{7}{8}$ in. in diameter and deformed, not a particle of concrete adheres to them. These bars were placed in the concrete without upturned ends. The débris comprising this buttress and parts of the slabs probably weighs 25 to 30 tons.



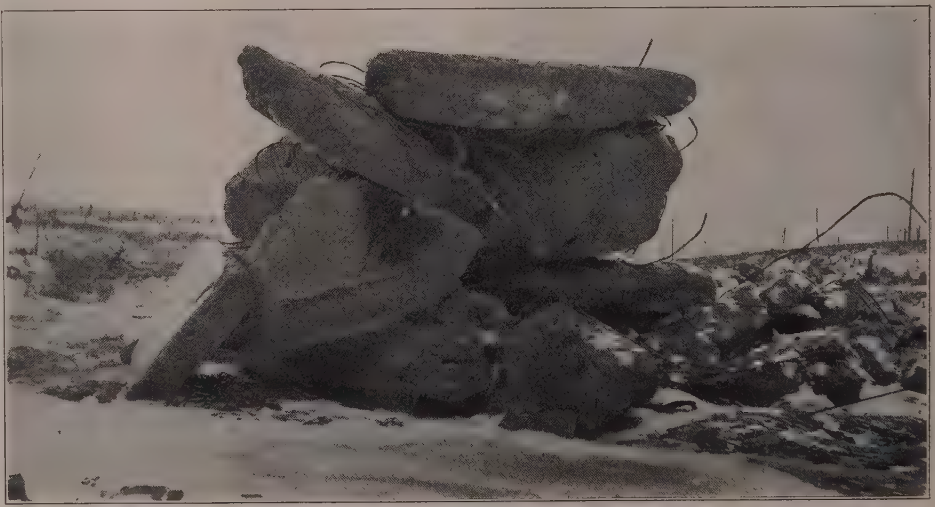
Ice Blocking Stairway to Operating Platform of Outlet Valves

The rush of water through the opening between buttresses 12 and 14 carried with it buttresses 14, 15 and 12 and the slabs between them and undermined the floor beneath buttresses 16, 17 and 18, causing it to loosen from the buttresses, break and sag down into the hole. The deck slabs between buttresses 15 and 16, hinged along buttress 16 by their reinforcing rods, swung downward in a plane normal to the deck of the dam, smashed against buttress 16 and broke the latter by their impact. Water, after passing through the break in the dam, was diverted to the river by the west bank, which was severely eroded. The accompanying photographs show what happened.

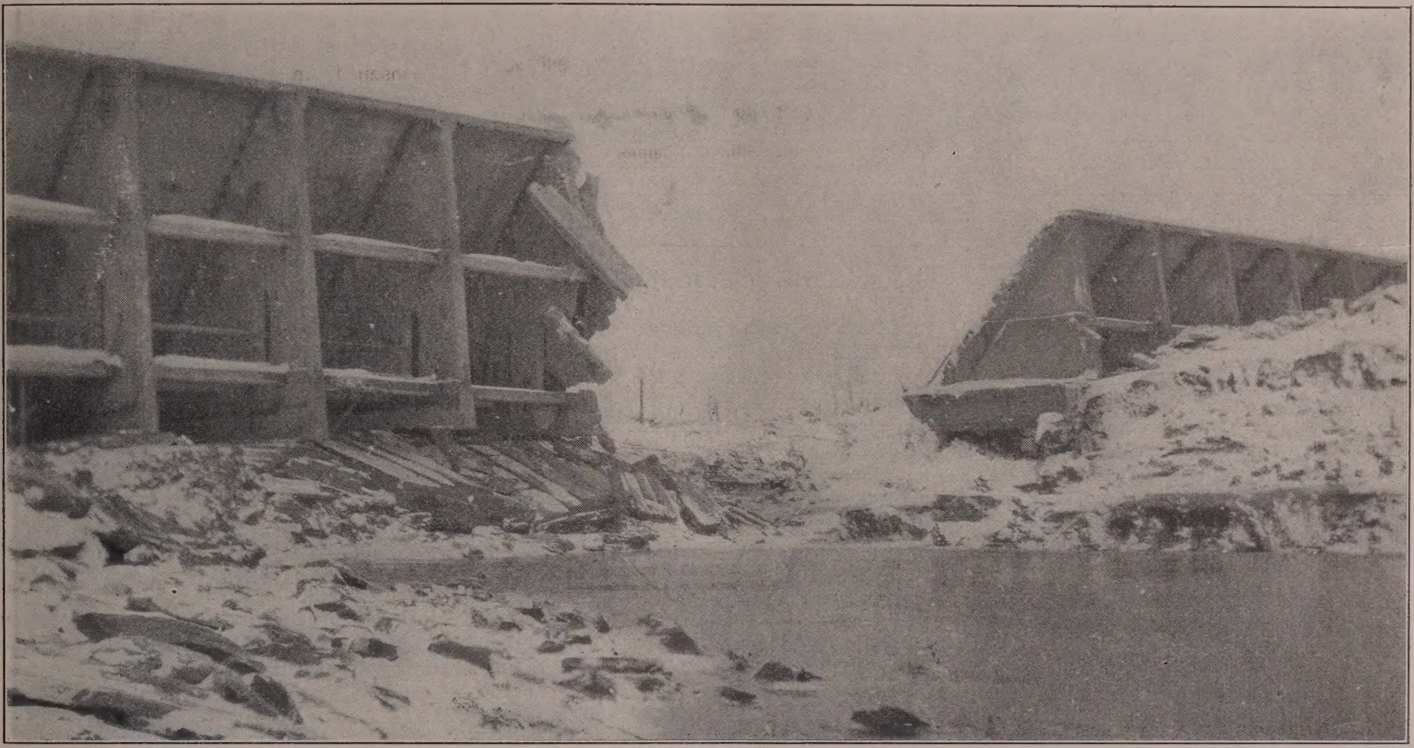
### Geological Formation

A close inspection of the break showed that the cutoff wall had not been carried down far enough to form an effective water seal at the point where the break occurred. On the accompanying drawing is shown the elevation of the rock and the depths to which the cutoff wall had been carried. The foundation is of a very treacherous nature and the rock bottom consists of sandstone. On top of the sandstone there are yellow clay, sand, gravel, blue clay, limestone, hardpan and seams of a peculiar black material, apparently a sedimentary formation of coal and clay of shaly consistence. It is soft, like drawing crayon, showing that it is not a part of the black shale found in coal veins. The east bank of the valley is traversed by a coal vein. Pockets of coal were found below the hardpan between buttresses 17 and 20 when the cutoff wall was excavated to bedrock. A piece of black material weighing a ton or more has been washed up from the hole. The original location of this piece is indeterminate, but it is likely that it was located directly under the dam. One fact confirming this belief is that the piece has been thrown up very near the wreck of buttress 13.

The so-called hardpan which formed the top stratum of the west bank was so hard, according to a statement of the engineer of the West Virginia Pulp & Paper Company, who supervised the examination of the ground, that "a blow with a pick could hardly loosen a piece as big as a walnut." The stepping up of the cutoff wall west of buttress 16 was determined upon by the engineer of the paper company and a representative of the Ambursen Hydraulic Construction Company, both of whom, it is reported, declared that this material was of a satisfactory nature. They then ordered the cutoff to be stopped 5 ft. below the

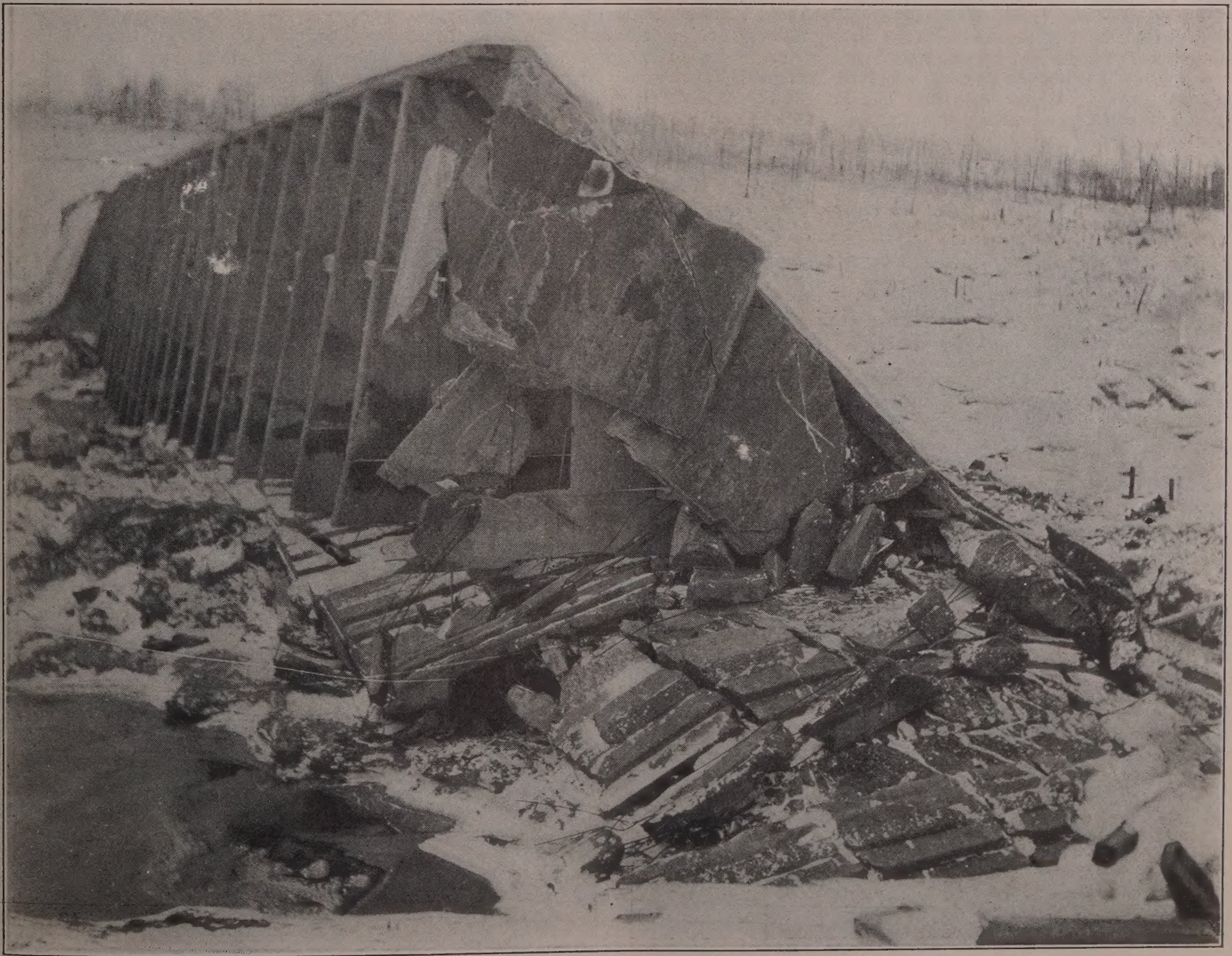


Fragments of Buttress 13 and Slabs Showing Stripped Reinforcing Rods

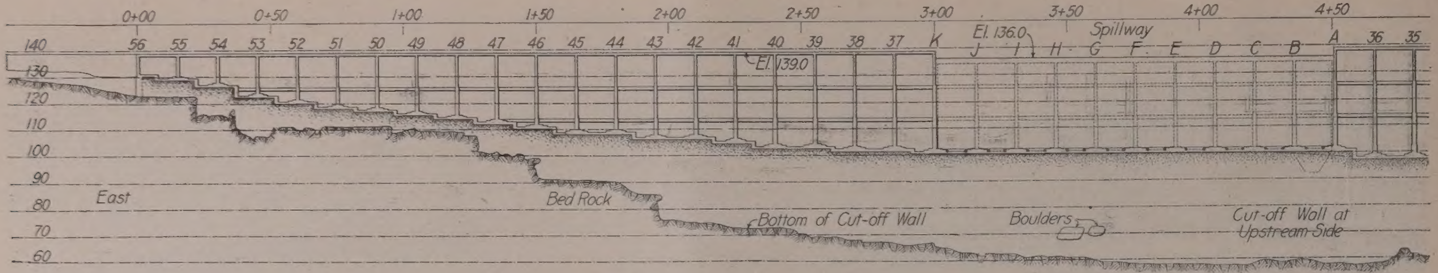


Break from Downstream Side, Showing Water in Deep Hole Washed Out by Rushing Water

Note Buttress 16 at left of opening smashed by impact with swinging deck slab and debris of broken floor



Looking East at Buttress 16, Showing Deck Slabs Hanging by Their Steel Reinforcing Rods and Fragments of Shattered Floor



Downstream Elevation of Stony River Dam (East Half), Showing Bottom of Cutoff Wall at Bedrock

bottom of the floor of the dam. This hardpan, after having been wet since last May and under full hydrostatic pressure for sixty-five days, is now nothing but yellow clay, sand and gravel loose enough to be broken by a kick from a man's shoe. It is to be noted, however, that where the cutoff wall—which is 3 ft. thick—was carried to rock, shoring of the trench was necessary, while no shoring was used in the hardpan.

### PERVIOUS SEAM

A close investigation of the foundation at the washout underneath the dam reveals the fact that between buttresses 12 and 13, where the cutoff wall had been carried down only 5 ft., is a pervious seam of coal and sand with some clay as binder. This seam, which is from ¼ to 6 in. thick and about 4 ft. wide, is located only 8 in. below the point where the cutoff wall was stopped.

An examination of the upstream side of the dam, covering the distance from the break to buttress 20—as far as the water has scoured the surface clean—shows that the horizontal joint between the cutoff wall and the deck has opened as much as ¼ in. in some places. Between buttresses 17 and 18 and 19 and 20—or where the cutoff wall has been stepped in the horizontal plane—this crack leaves the joint at buttresses 17 and 19 respectively and runs diagonally downward until it reaches the joint again at points where the step is formed. The locations of these cracks are shown on the elevation. It is obvious that such cracks point to a downward tilting of the whole structure, due to compression of the ground. The crack west of buttress 18 can, of course, be attributed to the washout of part of the floor beneath these buttresses, but this explanation cannot be given for the crack east of buttress 18.

### DAMAGE BELOW DAM

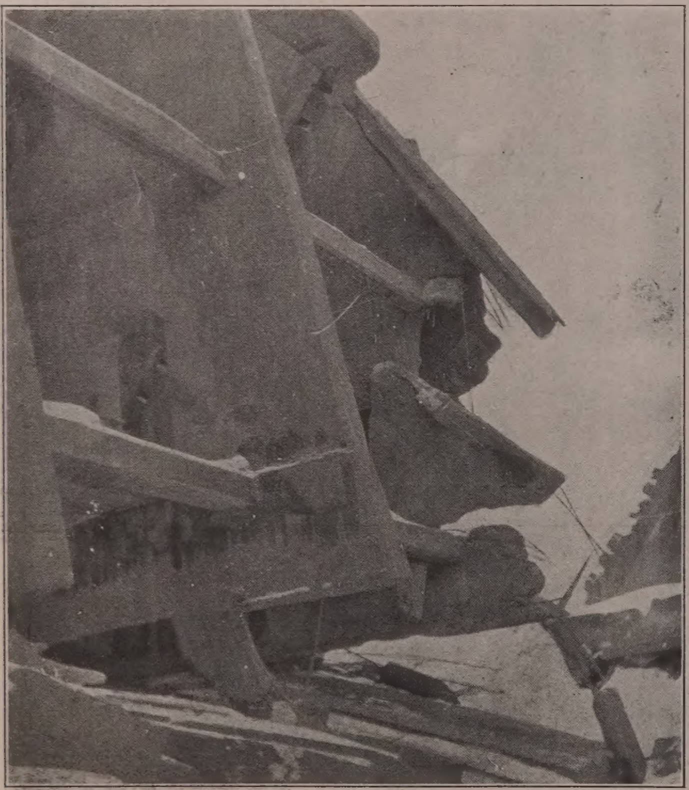
As soon as buttress 13 had given way the pond level fell quickly about 20 ft. The rushing water caused a scour of the bank below the dam and formed a small pool with its water surface at about El. 100. How deep this pool is cannot be definitely stated, but it probably goes down to bedrock. Above the water surface there is a 30-ft. high washout of the bank.

In the Stony River the water formed a wave about 8 ft. high, judging from the marks left upon the snow along the shores. About 12 miles below the dam an old steel highway bridge of 100-ft. span crossed the river. This bridge was washed out and completely destroyed. Near Schell, W. Va., the Stony River flows into the Potomac at an angle of 70 to 75 deg. On the north shore the Western Maryland Railway has its right-of-way. At this point the water piled up to a probable height of 15 ft. or more, causing a 30-ft. washout of the embankment. The wave then flattened out again and at certain points was only 4 ft. high, to judge by the deposits of logs and débris. About 7 miles further down the Potomac, where the river makes a sharp curve, another embankment washout occurred. Both of these washouts were repaired and traffic was restored on Saturday, Jan. 17. The first washout was repaired by shifting the track, putting in a cribbing of 10 x 10-in. longitudinal timbers and 6 x 6-in. binders along the river, dumping thirty carloads of cinders and ashes into the hole and shifting the track back again. At the other washout, which was much smaller, the track was shifted about 3 ft. away from the river and left there.

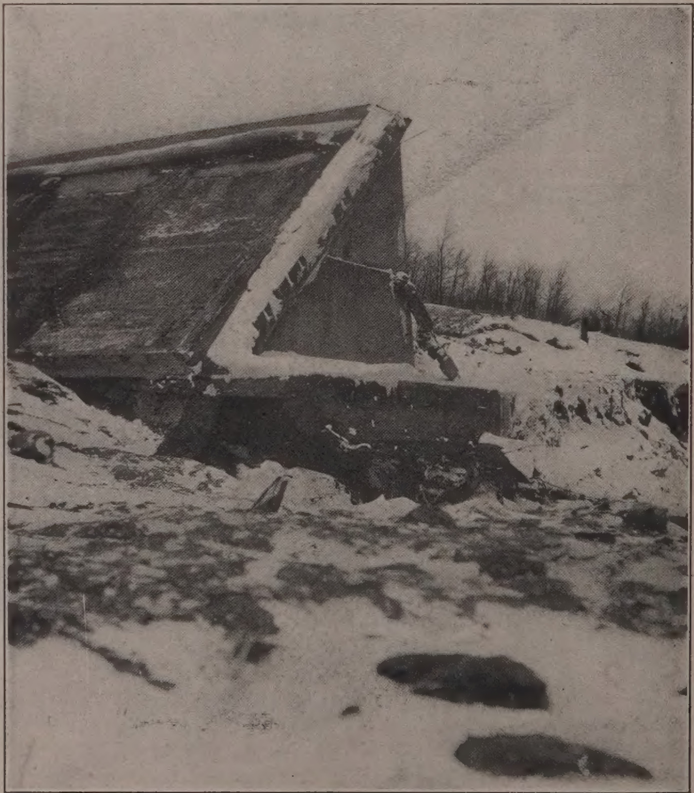
### BRIDGES WASHED OUT

The Potomac in a number of places is crossed by small wooden suspension bridges with steel cables. At a number of these bridges the floors were washed away, but nearly all of them were repaired Monday, Jan. 19. The only point where danger to life and property existed was at Gleason, where several sheds were destroyed and back yards filled with débris. At Luke, Md., and Piedmont, W. Va., the wave hardly reached a 4-ft. stage. This is even less than the usual spring freshets at that point. Against the piers of every bridge along the Potomac River as far down as Cumberland, Md., débris is piled high.

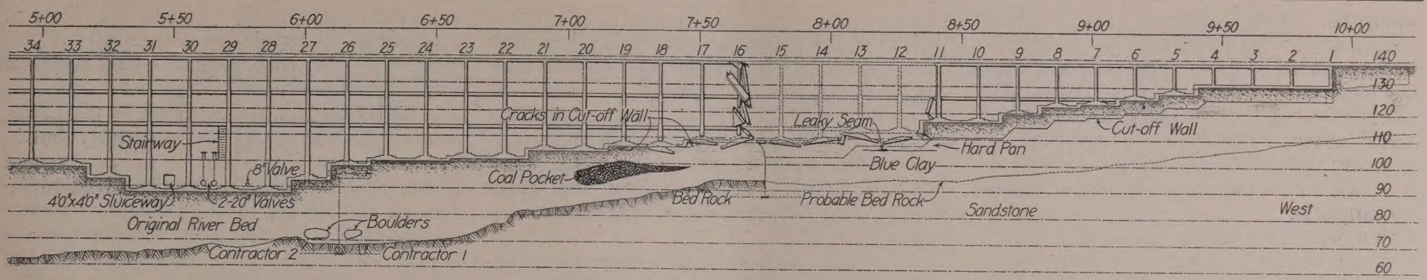
The contract for building the dam was



Broken Joints between Buttresses and Floor



Break in Cutoff Wall at Buttress 11



Elevation (West Half) Showing Seam Near Break and Character of Underlying Material

let to the Webber Construction Company, which started work June 13, 1912. As the progress of the work was considered by the West Virginia Pulp & Paper Company to be too slow the company paid off the contractor in March, 1913, and gave the contract to the Ambursen Hydraulic Construction Company, of Boston, to complete. This company finished the dam during the summer of 1913. For the paper company Mr. R. P. Bloss was engineer. Mr. Edward Wegmann served as consulting engineer until the construction of the dam was begun. Both the Ambursen company and the paper company had a resident engineer at the site of the work.

In May, 1913, the pond was allowed to fill as the construction work progressed, and on Nov. 11, 1913, exactly sixty-five days before the dam broke, the spillway overflowed for the first time. To regulate the discharge of the pondage of the dam there are two 20-in. valves in the panel between buttresses 29 and 30. Between the downstream ends of these buttresses is a measuring weir, so as to enable the caretaker of the dam to estimate the discharge. In the panel between buttresses 30 and 31 is a 4-ft. square sluiceway, closed by a gate, and in panel 28 and 29 is an 8-in. valve. The operating mechanisms for these outlets are all of the same type, hand-operated through a screw stem by bevel gears. These operating devices were not housed, and no precautions had been taken to keep them in operating condition during low temperatures. Inspection disclosed the fact that the stairway leading from the walkway through the buttresses of the dam to the valve-operating platform was one solid block of ice, extending up to the under side of the deck. This ice formation was due to a leak between the slab and buttress 29. The pulp company's engineer stated that an expansion joint was located at that point and that the leak occurred through it. Neglect to house these operating devices and leakage through the deck brought about the condition which prevented the opening of the outlets. After the dam broke and the pond level fell about 20 ft. a discharge of 4 or 5 sec.-ft. (the runoff from the drainage basin) ran through the break. The caretaker then succeeded in reaching the valves, thawed them out and diverted the discharge through them. This left the broken parts of the dam above water, so that a close investigation could be made.

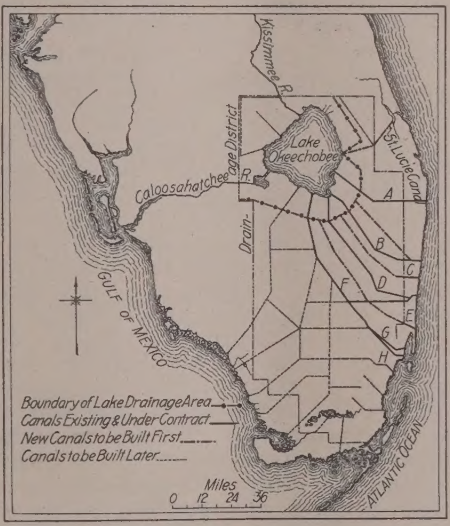
### RÉSUMÉ

The failure of this dam is not due to one cause, but to a combination of several conditions. It is apparent from the investigation that the cutoff wall had not been carried down far enough to prevent leakage under the dam. Had the valves been housed and kept in operating condition the pond might have been drained during the twenty hours that elapsed between the time the leak was first noted and the break occurred.

# Reclaiming the Florida Everglades

## Engineering Commission Proposes to Prevent Flooding from Lake Okeechobee by Means of a Short Canal Direct from Lake to Sea

A NEW means of facilitating the drainage of the Florida Everglades is proposed in the official report recently made public of the Florida Everglades Engineering Commission, consisting of Messrs. Isham Randolph, chairman, Marshall O. Leighton and Edmund T. Perkins. The main element of the problem is to take care of the surplus water from Lake Okeechobee, which is fed by streams from the north and which at times overflows the southern rim of the lake and floods the entire Everglade district. Previous drainage schemes, including that recommended by the board of engineers who investigated the problem for the Everglades Land Sales Company, and whose report was abstracted in the Engineering Record of Oct. 25, 1913, page 454, have been confined to a series of canals from the lake to the sea to take care of these flood waters, and such auxiliary canals and ditches in the district to be reclaimed as might be required to carry off the rainfall within the district. It is now proposed, however, to construct an independent outlet to the sea—indicated on the accompanying map as the Okeechobee-St. Lucie Canal—sufficient to care for all of this overflow. "With these extraneous flood waters diverted as indicated," says the report, "the problem of draining the Everglades is reduced to proper provision for carrying off the precipitation upon them. This can be accomplished by adding to the main canals which now traverse this territory—canals now surcharged with waters flowing out of Lake Okeechobee—other canals, the courses of which are indicated."



Map of Lower Florida Peninsula

A, West Palm Beach Canal; B, Hillsborough Canal; C, Cypress Creek Canal; D, North New River Canal; E, Snake Creek Canal; F, South New River Canal; G, Miami Canal, and H, Snapper Creek Canal.

Further notes are taken from the report as follows:

### LAKE OKEECHOBEE

Lake Okeechobee has an area of about 730 sq. miles and is, with the exception of Lake Michigan, the largest body of fresh water wholly within the United States. Its surface ranges from El. 16 to 22. The basin receives the floods from a watershed of 5366 sq. miles. When its capacity is exceeded the excess waters spill over its southern edge and flow southward over the 4000 sq. miles of the Everglades. Several outlet canals, the initial part of a progressive drainage system, have been dug, but under present conditions these are so surcharged with water from the lake as to keep the Everglades wet.

The idea widely held that the problem cannot be solved by progressive steps, but that the whole area must forthwith be covered by interdependent canals, is believed to be erroneous. With Lake Okeechobee brought under control it is thought that the region now flooded can be relieved by adequate main drainage outlets and subsidiary canals whose capacities may be adjusted to meet the needs of the territory they serve.

### PRESENT NEEDS

At present the North New River, the South New River and the Miami canals have been completed, as well as the one westward to the Caloosahatchee River. The Hillsborough, Cypress Creek, Snake Creek and Snapper Creek canals are under construction and the contract for the West Palm Beach Canal has been let. This system contemplates the reclamation of a greater portion of the Everglades in the immediate future than will be justified by the demand for new lands. The existing works, however, and the conditions of land, ownership and settlement seem to necessitate an earnest effort to reclaim in one continuous project all the lands south and southeast of Lake Okeechobee between the Miami and the West Palm Beach canals. To this end it is proposed to construct the intermediate canals 8, 9 and 10 from the boundary line of the district to drain into the lowered lake to the ocean or existing canals.

These new canals would have a combined length of 136 miles and would drain 1011 sq. miles. The estimated cost would be $2,972,000, figuring the excavation at 9 and 10 cents per cubic yard. Enlargement of the existing canals would also be required.

About 211 miles would have to be so enlarged, at an estimated cost of $1,207,200. Four standard locks at $25,350 would make the total cost of work to be undertaken at once, exclusive of the Okeechobee-St. Lucie outlet, $4,281,000. Thus 2095 sq. miles or 1,341,000 acres would be drained, at a cost of $3.20 per acre above present expenditures.

The territory embraced in this system of canals is one of five districts into which the entire region may be divided. The other four are between Miami and Detroit, the Allapattah flats in the northeast section, the northwest corner beyond the lake, and the southwest section. The estimates for the improvements in these four districts are respectively $613,000, $372,000, $714,420 and $14,630,000. In each instance, except for the southwest district, the cost per acre is in the neighborhood of $4. That for the southwest district would be $7.70.

### St. Lucie Outlet Canal

The St. Lucie outlet canal would be about 24 miles long. It would be 12 ft. deep and would have a bottom width of 200 ft., with a 30 x 130-ft. lock at the point of discharge into the St. Lucie River. It has been planned for a capacity of 5000 cu. ft. per second at El. 16 and 7000 cu. ft. per second at El. 19. The estimated cost, including canal, lock system and power plant, is estimated at $2,500,000.

It is recommended that the whole cost of this canal should not be charged against the Everglades. The canal would control the lake for land drainage and flood storage, would provide a 12-ft. navigable stream and would afford a water power of primary capacity of 5000 hp. Equal parts of the cost should, therefore, it is believed, be charged against the drainage district, against navigation and against the water-power plant. It is estimated that an annual income of at least $200,000 would be obtainable from the sale of the power. Deducting the fixed charges, estimated at $90,000 annually, $110,000 would be available for operating charges and drainage-district maintenance.

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## Annual Meeting of the American Society of Civil Engineers

### Account of Proceedings of Introductory Session Held January 21 at New York

THE sixty-first annual meeting of the American Society of Civil Engineers took place at the society house in New York City, Jan. 21 and 22. The larger part of the discussion at the business session was devoted to the amendments offered at the annual convention last June. It was finally ruled that the meeting could take no action on them. Three special committees presented progress reports. Applause greeted Secretary Hunt's announcement that for the first time in its history the society is practically out of debt.

The annual report of the board of direction for 1913 showed a gain in membership of 495, the total for Dec. 31, 1913, being 7272, as compared with 6777 at the close of 1912. The library now contains 23,357 bound volumes, 44,405 unbound volumes, 7420 specifications and 4674 maps, photographs and drawings—a total of 79,856 and a gain of 4022.

Twenty-six meetings, at which the attendance was 5220, were held during the year. At these meetings twenty-nine formal papers were presented, in addition to twelve published but not discussed in any meeting. The number of members and others who took part in the preparation or discussion of these papers was 275. The experiment of holding one of the regular meetings outside of the resident district was tried, and the meeting scheduled for Oct. 15, 1913, held at New Orleans, was a success in every way.

Four new special committees were appointed, as follows: (1) To codify present practice on the bearing value of soil for foundations; (2) on a national water law; (3) on floods, flood prevention and other allied subjects, and (4) on stresses in railroad track. In addition, the six special committees all submitted progress reports during the year.

During the year $35,000 was paid on the mortgage of the society, reducing the debt to $80,000. The reserve fund now consists of $80,000 (par value) New York City bonds, on which the interest is slightly more than that on the mortgage; hence the society may be said to be for the first time out of debt.

### Constitutional Amendments

Extended discussion followed the report of the committee on proposed amendments to the constitution. The constitution contains the provision that proposed amendments, signed by five or more corporate members and presented at least sixty days before the annual convention, shall be subject to discussion and may be amended in any pertinent manner by the convention. Thereafter they must be submitted, in their original form or as revised, to a letter ballot of the society, or else referred to a committee for further amendment. In the latter contingency, which arose last June, owing to the simultaneous proposal of amendments contradictory to each other, the constitution states that the committee "shall report at the next general meeting, whereupon the amendment shall be voted upon as hereinbefore provided." The revised amendments were therefore offered at this annual meeting. Strong opposition to some of these amendments, particularly one eliminating the secretary of the society from the board of direction, developed, and several members, understanding that the matter was open for action, attempted to get their disapproval on record. Amid the confusion arising from various interpretations of the constitution and the proper means of dealing with the committee's report the chair finally ruled that the meeting could not take any action, and that the propositions must be submitted to the members for a letter ballot.

### Reports of Committees

Progress reports of the committees on valuation, on bituminous materials for road construction and on conditions of employment and compensation of civil engineers (reprinted elsewhere in this issue) were accepted with thanks. The committees on steel columns and struts and on bearing values of soils also submitted brief progress reports.

The committee on engineering education, through its chairman, explained that after preparing a rather elaborate report the committee had at the eleventh hour decided not to submit it. The reason was that the Carnegie Foundation for the Advancement of Teaching, which had for two years turned a deaf ear to the appeals of the committee for co-operation, had, in a letter dated Jan. 2, signified its readiness to conduct, at its own expense, a thorough investigation of the subject, co-operating with all of the national engineering societies.

A letter written last summer to the president of the society by Mr. Augustus Smith, proposing the formation of an arbitration board of from fifty to one hundred members of the society, to adjudicate engineering controversies and keep disputes out of court, was read. The conclusion of the board of direction, however, after careful consideration of the matter, was that while arbitration is desirable, the plan of creating such a board is not feasible at present.

A motion was made that a letter ballot be taken on a resolution to the effect that the society thinks it to be in the public interest that the practice of engineering should be regulated by statute. On the ground that the merits of such a resolution should first be passed upon by the board of direction, the matter was tabled. In that connection, however, Secretary Hunt announced that a joint committee of the five national societies was drafting such a statute to forestall vicious legislation.

A joint committee, to act with representatives of the American Railway Engineering Association, to investigate stresses in rails, ties, etc., announced as follows: Chairman, A. N. Talbot; A. S. Baldwin, J. B. Berry, G. H. Bremner, John Brunner, W. J. Burton, C. S. Churchill, W. C. Cushing, E. Gerber, R. W. Hunt, G. W. Kittredge, William McNab, G. J. Ray, F. E. Turneaure and J. E. Willoughby.

### Awards of Prizes

Announcement was made by Secretary Hunt of the awards of prizes during the year. Mr. J. V. Davies won the Norman Medal with his paper, "Air Resistances to Trains in Tube Tunnels." Mr. Burgis G. Coy won the Thomas Fitch Rowland Prize with "The Laramie-Poudre Tunnel." Two new awards were made as follows: the J. James R. Croes Medal to Mr. B. F. Cresson, Jr., for "The Problem of the Lower West Side Manhattan Water-Front of the Port of New York," and the James Laurie Prize to Mr. M. M. O'Shaughnessy, member, for "The Construction of the Morena Rock-Fill Dam, San Diego County, California."

Officers for the coming year were elected as follows: President, Hunter McDonald; vice-presidents, Charles F. Loweth and Gardner S. Williams; treasurer, John F. Wallace; directors—district 1, George W. Fuller and Arthur S. Tuttle; district 2, Charles H. Keefer; district 3, Mortimer E. Cooley and Eugene E. Haskell; district 5, Richard Montfort; members of the nominating committee, Lewis D. Rights, Joseph R. Worcester, Frederick E. Turneaure, Thomas Earle, John W. Woermann, Thomas U. Taylor and Milo S. Ketchum.

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Chicago's Typhoid Death Rate in 1913 was 10.5 per 100,000, the second lowest ever recorded. It was a "typhoid year" throughout the country and investigation by the Board of Health showed 21.7 per cent of the cases were imported. Only two unusual developments occurred—a milk-borne outbreak and an infection of forty-eight patrons of a restaurant served by a typhoid carrier. For the ten-year period beginning 1903, the rates have been 31.8, 19.6, 16.9, 18.5, 18.2, 15.8, 12.6, 13,7, 10.8, and in 1912 7.5, an average of 16.5 per 100,000 population. The main channel of the Sanitary District was opened in 1900.